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OKLAHOMA OIL AND GAS
ENVIRONMENTAL ANALYSIS RECORD
(Albuquerque District)
August 30, 1974

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ENVIRONMENTAL ANALYSIS RECORD
Oklahoma Planning Unit
Albuquerque District

INTRODUCTION

Purpose and Structure of Environmental Analysis

This Environmental Analysis is intended to identify impacts from oil and gas activities in the Oklahoma Planning Unit and explore ways and means of minimizing adverse impacts. It will be used as a tool to assist the Bureau of Land Management (BLM) in carrying out its responsibilities with regard to oil and gas leases and operations. These responsibilities, in association with the United States Geologic Survey (USGS), include processing of lease applications, drilling permit applications, notices to conduct exploration, notices to abandon wells, and various rights-of-way and Special Land Use Permits. These responsibilities are detailed in Sec. Order #2948 (Attachment #7).

Environmental values are considered in the Bureau's decision making system. These guidelines are to be used in evaluating and mitigating impacts on the environment. The decisions as to whether oil and gas activity might be restricted in certain areas are determined through the BLM planning process.

This report is structured to be a land management tool as well as an analysis of impacts. The study area which is the Oklahoma Planning Unit, is discussed in each section, with specific sensitive or vulnerable areas identified. This is to insure full consideration of the most fragile and irreplaceable of the resources in the area.

It should be noted that the Bureau of Land Managemeant is currently preparing a Bureau-wide environmental statement report on the oil and gas leasing program. This statement will provide a thorough discussion and evaluation of the history, background, regulations, general impacts, etc. of the over-all program. In addition, it will provide an in-depth discussion of alternatives, such as other energy sources. It is intended that the Bureau-wide environmental statement coupled with this specific environmental analysis will provide the necessary considerations and the proper protection for the environment in the Oklahoma Planning Unit.

I. DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

A. Proposed Action

The proposed action is the continuation of the oil and gas leasing activities on the national resource lands (NRL) and mineral reserved lands within the Oklahoma Planning Unit of the Albuquerque District, Bureau of Land Management.

1. Procedure

The following is a short discussion of the steps ordinarily followed in oil and gas activities:

Geophysical and Geologic Exploration

Geophysical exploration is any activity, relating to the search for evidence of oil and gas.

Exploration crews must file a Notice of Intent with the District Manager (Attachment #3). This requirement does not apply to a lessee or an authorized contractor for the lessee in conducting exploratory work within his leased area. The notice provides for BLM input to protect the environment under terms and conditions of this form.

After completion of exploration activities, the company must file a "Notice of Completion of Oil and Gas Exploration" with the District Manager. Within 90 days, the District Manager will notify the party who has conducted the operations if he must take corrective steps.

Leasing

At this point, it is necessary to be aware of the steps taken by the District Office upon receipt of a proposed lease from the State Office. When a particular parcel is described in a proposed lease, the District BLM personnel will refer to their maps, etc. to find the location of the proposed lease. When this is determined, the appropriate sections in this report and other available information will be used to determine special problems and subsequent special stipulations to be attached to the prospective lease. Most of these stipulations are located in the "Recommended Mitigating or Enhancing Measures" section of this analysis.

Drilling Permits

This action takes place after a lease is issued. Leases issued after November 1972, include a standard set of open end stipulations which allow BLM to determine conditions of surface activity (Attachment #8). Applications to drill are filed with the USGS for approval.

Departmental Order #2948 Sec. 2(a)(Attachment #7) requires the Geological Survey to consult with the BLM on the adequacy of the surface use, environmental protection, and reclamation aspects before approving any applications to drill, abandonments of wells, or certain other operations. The USGS requires that each Application for Permit to Drill be accompanied by a Development Plan for Surface Use (Attachment #4).

The BLM reviews the surface plan after receipt from USGS and then replies to USGS as to its adequacy and includes recommendations, if any. (BLM and USGS Field Guidelines, Attachment #6).

The surface activities subsequent to drilling are production, pipelines, powerlines, further exploration, roads, and finally abandonment.

2. General Boundaries of the Area

The Oklahoma Planning Unit is shown on Attachment #1 and consists of the entire state of Oklahoma.

3. Authority

Oil and gas leases on federal lands, both public and acquired, are issued by the State Office (Santa Fe) after consultation with the District under the authority of the Mineral Leasing Act of February 25, 1920, as amended (44 Stat. 437,30 USC 181 et. seq.), and the Acquired Lands Mineral Leasing Act of August 8, 1947, (61 Stat. 913,30 USC 351-359).

4. Land Subject to Leasing

All lands subject to disposition under the Acts may be leased by the Secretary of the Interior. Acquired lands may not be leased except with the consent of the agency having jurisdiction over the lands as discussed below. Land in incorporated cities, towns, and villages are not subject to leasing under the above Acts.

5. General Information - Current Extent of Oil and Gas Activities

Oil and gas resources constitute a major part of the economy in Oklahoma. Production of these minerals occur in almost the entire state, in fact 71 of the 77 counties in Oklahoma now have or have had oil and gas production.

Oklahoma is well known as the oil state; this reputation was established during the big oil boom from about 1912 to 1929. Oil and gas production is now valued at about one billion dollars annually from this state, (1972 prices). In 1970 Oklahoma ranked third in production of natural gas, helium, and liquified-petroleum gas, and fourth in crude oil. Oil and gas revenue has been either the first or second leading resource in the state for all of the last 25 years.

The recent field examination in Oklahoma revealed that there are a large number of companies that are drilling new wells. This was expected since a large part of the state already has producing oil and gas fields. The USGS commented that they expect this activity to continue to increase and they expect oil and gas production to increase considerably.

Types of Leases

Simultaneous oil and gas leases are for lands outside a Known Geologic Structure (KGS) area. If more than one offer to lease is filed for a particular parcel, a public drawing is held at the end of the filing period. These parcels may be designated by the BLM or may result from areas where existing leases have expired, been terminated, were relinquished or had been cancelled.

Non-competitive over the counter oil and gas leases are also outside a KGS area. The base action may be initiated by the applicant and may be issued providing he qualifies. They are issued without competition or drawing.

Competitive leases are issued for all lands within the boundaries of a KGS as defined by the United States Geological Survey (USGS). Leases in such areas can be issued only as a result of a competitive oil and gas sale. These types of leases comprise the largest percent of all leases issued within the planning unit.

Well Spacing Regulations

Regulations governing the spacing of oil and gas wells are established based on data from discovery wells. Formation porosity and permeability, flow pressure, producing rate, depth of producing zone, lithology and type of oil, are all factors which are considered when the proper government authority determines the well spacing set. Development drilling in a field will be in conformity with government field spacing regulations. The standard spacing for an oil well is 40 acres and for a gas well is 640 acres unless otherwise provided in special pool rules. As the fields develop, the wells are interconnected with a road and pipeline system. It is possible that sixteen oil wells per square mile could be drilled resulting in at least 4 miles of road and 4-6 miles of a pipeline system per square mile of field. The pipeline gathering system is a series of interconnecting flow lines which transport the produced oil and water or oil and gas to the central processing facilities. It is not unusual for several wells to be drilling at the same time, especially if there is more than one operator with leases in the field area.

6. Planning Unit Information

The Inventory, Analysis and Action Plan for the Oklahoma Planning Unit is scheduled for completion in FY 1975. The District is presently using available information from publications developed by various county, state, and federal agencies in processing any applications associated with oil and gas activities.

7. Stages of Implementation

Oil and gas operations and activities in the unit follow a recognized four step sequence of: exploration, development, production and abandonment.

Exploration

Many of the exploration activities which affect the land, resources and environment take place prior to the issuance of a lease and therefore, pre-lease and post-lease operations will be analyzed and described separately. Much of the planning unit is in KGS areas where pre-lease exploration has not been very active for several years. Since much oil and gas data already exists, pre-lease exploration is less active than it would be in a wildcat leasing area and little pre-lease exploration is done. The following is a brief description of exploration practices. (For more detailed information see Programmatic Environmental Statement, Upland Oil and Gas Leasing).

Pre-leasing exploration operations conducted prior to obtaining an oil and gas lease may be segregated into two categories. Airborne exploration, which does not require physical presence on the ground and surface exploration, which requires either casual or intensive activity on the ground. Casual activities include the use of existing roads and trails to conduct a variety of surveys. Intensive use may result in disturbance of the environment to varying degrees. Construction of temporary access trails, clearing of the vegetative cover for an exploration site or movement of heavy equipment and vehicles cross country characterize intensive use.

There are a number of geophysical surveys which may be conducted during the exploration phase, examples are:

a. Explosive method

b. Thumper method

c. Vibrator method

In the explosive method, a truck mounted drill is used to drill holes 100 to 200 feet deep on 600 to 1,400 foot spacing. The holes are loaded with 5 to 50 pounds of explosives and detonated. The same hole may be reloaded and shot numerous times to find an optimum depth and explosive charge to return the best reflection or refraction signal possible.

The thumper and vibrator method both use truck mounted equipment as an energy source to pound or vibrate the earth. All three seismic methods use recording equipment or detectors which are placed on or in contact with the ground at spaced intervals to record the time it takes the impulse energy to be returned from the subsurface.

Exploration operations subsequent to obtaining an oil and gas lease are conducted by drilling operations to discover hydrocarbons. Drilling operations that fall in the category of exploratory "wildcat" wells are approved by the USGS only after an environment analysis is made that has the concurrence of BLM and has resulted in a determination that such action does not constitute a major federal action significantly affecting the environment in the sense of NEPA, Section 102(2) (c).

The location of the well site is derived after consideration is given to geophysical exploration data in conjunction with subsurface data gathered from previous wells drilled in the area. Once a site has been selected, a road is built that can support the drilling rig and other equipment that must be moved to the location. The most economical route is desired by the operator. These roads are not designed for permanent access until production is established in an area. The well site covers an area ranging from 200 x 200 feet up to 300 x 300 feet (approximately 1-2 acres) which is cleared of vegetation and graded to a flat surface.

Depending on the soil in the area, the drill pad and roads may or may not be gravelled. At the well site, the drilling rig, mud pumps and tanks, reserve pit, generators, pipe rack, and tool house are located on the drill pad. Other facilities, such as storage tanks for water and fuel, may or may not be located on the drill pad; however, they will be located nearby.

One key to successful rotary drilling is the washing of the hole by fluid (referred to as mud), continually pumped down the drill pipe to remove drilled cuttings. Basically, drilling mud performs the functions of (1) removal of cuttings from the well, (2) maintenance of sufficient hydrostatic pressure to prevent entry of high pressure hydrocarbons or water from drilled formations, (3) keeping the drill bit cooled, (4) holding cuttings

in suspension when circulation is temporarily stopped, (5) aiding in the prevention of caving of soft formations by means of the density and plastering properties of the mud, (6) reduction of the amount of water lost from the drilling fluid to the formations drilled by plastering the walls of the hole, (7) supporting part of the weight of pipe in the hole, and (8) release of cuttings as easily as possible when at the surface. Drilling fluids have weight, viscosity, gel-strength, wall-building and filtration rates, electrical resistivity, and chemical properties.

When drilling with mud, the drill cuttings from certain formations are caught (sampled) at given intervals and examined by a geologist to detect hydrocarbons and to obtain geologic correlation. If the drill cuttings give a good indication of oil or gas, the geologist may recommend testing the interval from which the samples came. Testing is usually done by (1) a "drill stem" test shortly after drilling through such interval, and/or (2) at completion of drilling by casing the hole, selectively perforating, fracturing the formation, and testing.

During drilling operations, certain strings of casing are placed and cemented in the hole. They are classified in the basic categories of surface casing, intermediate casing, and production casing. Each string of casing serves an important part in drilling and completion operations.

At the completion of testing and drilling, the well is logged. This is an operation wherein some characteristic data of the formations penetrated by a borehole are recorded in terms of depth. In oil and gas operations, the five prevalent varieties of well logs are electrical, radioactivity, sonic, sample, and mechanical. The well logs provide information which is used in the completion process of the well.

Well completions fall into three basic categories: (1) open hole completions, (2) liner completions, (3) perforated casing completion. In brief, (1) the open hole completion method calls for production casing to be set above the zone of interest prior to drilling same, and the well is completed with the producing interval open to the well bore; (2) the liner completion calls for casing to be set above the producing zone, and an uncemented screen and liner assembly is installed across the pay section

(producing interval); or, after the pay is drilled with casing above it, a liner casing is cemented in place and perforated; (3) production casing is cemented through the producing zone and the pay section is selectively perforated.

After perforating, the pay zone is treated or fractured in the hope of stimulating production.

The drilling rig and much of the support equipment is moved away from the well site, either after the casing is cemented in the hole or after the producing zone is treated.

Any oil well completion from a producing zone could result in a well which may have to be pumped from the initial stages of its life, or it may have a flowing life followed by a period of mechanical lift.

If the well is a gas discovery, the operator will vent or flare the gas for a short period to clean up the well and to test the well's capabilities. A gas well will then be shut-in waiting for a connection to a gas sales line.

Development

After a discovery of a new field, subsequent wells will be drilled until the reservoir limits of commercial production are established. Such wells will be drilled on an established spacing regulated by governmental agencies.

The drilling of all wells where a federal oil and gas lease exists is subject of USGS approval. Attached to and made a part of an application to drill is a "Development Plan for Surface Use," which must receive the concurrence of the BLM before any development drilling activities can be initiated in areas under BLM jurisdiction. (See Attachment #4 for "Plan Requirements").

In Oklahoma, some areas are under unitization. Basically, unitization is the pooling of interests in one or more reservoirs with one company being responsible for all operations. Production

is allocated to lands in participating areas, and production is controlled to gain the maximum recoverable hydrocarbons. Several of the units covering oil reservoirs are in a stage of secondary recovery and are rapidly declining in productiveness.

The drilling of development wells will require additional access roads and well sites; however, these will usually be of a permanent nature with a stable base, and their location and construction methods better planned than for exploratory wells.

If the discovery is gas, environmental disturbances may be significantly less since gas wells are normally drilled on larger spacing and usually do not require the surface facilities that oil wells do.

The impact due to field developments does not increase proportionately with each new well since many existing roads and facilities may be used. As each well is drilled, additional subsurface data is obtained and analyzed. This data is correlated to enable the operator to change his development plans and also to reduce the number of unnecessary wells.

Many fields go through several development phases -- that is, some of the new development wells may be drilled past the known producing horizon in an attempt to find additional pay zones. Occasionally, tests are made in deeper zones to locate other producing formations. If a deeper pay zone is developed within the field area, there may be additional wells drilled adjacent to existing producing wells, or in some instances existing wells may be drilled deeper and used as a multiple completion. Each additional deeper pay zone usually requires a more complicated completion with additional storage and treatment facilities.

Production

Production begins when the oil and/or gas can be marketed, whether by a pipeline system (oil or gas) or by trucking (oil).

Much of the oil and gas activity in the Oklahoma Planning Unit is considered to be in the production phase. However, there is continued drilling to define field limits and to discover new

production. During the production life of a field, a continuing study of the producing reservoir is pursued to obtain data for possible use by the operator to recover additional volumes of oil, and to help in selecting the optimum time for secondary recovery initiation.

The surface production facilities depend on several factors, such as oil or gas production, phase of production (initial or secondary), depth of production, volumes being produced, and mixture of fluids being produced. Such facilities may consist of one or more of the following: (1) a well head, (2) pumping equipment, (3) a separation system, (4) flow lines, (5) a meter system, (6) storage facilities, and (7) water treatment and injection facilities.

Well Head - Well heads consist of several different combinations of equipment which may include a casing head, casing hanger, intermediate casing head, tubing head, tubing hanger, tubing adapter, valves, trees and crosses, chokes and flow controls, and tree top.

Pumping Equipment - The most common type of oil or fluid lifting type equipment is the sucker-rod pumping system with the pumping motion supplied at the surface by a pumping jack.

Separation System - Inasmuch as gas and oil, oil and water, or even gas, oil, and water occur together in the well bore, their separation at the surface is a basic problem. Various type separation equipment and systems do this and are found at well and tank batteries throughout the areas. The equipment falls into classes of separators, stabilizers, scrubbers, heater treaters, and precipitators.

Flow Lines - Flow lines go from the well head and/or well location facilities to a sales transmission line in the case of gas; and for oil, the lines go to storage tanks which may be at the well location or centralized at a common storage tank battery.

Meter System - Gas produced goes through a meter run and/or meter house where the volume, temperature, and pressure are recorded. The meter house is usually a small tin shed. Oil produced can be manually gaged and transported either by truck or through a sales line; or it can go through a lease automatic

custody transfer to a sales line. The automatic custody transfer system is merely equipment and instrumentation to transfer custody of oil to a pipeline at a producer's lease without a representative of either having to be present and with all measuring and testing done automatically.

Storage Facilities - Surface storage tanks for oil may vary in size from 210 barrel tanks, usually found at individual wells, to several hundred-barrel capacities. This depends on total well or lease production and whether the oil is marketed from the well site or from a lease tank battery system. Some of the lease storage batteries will have fire walls constructed around them (dirt dikes). It is common practice to construct open pits in association with storage facilities to bleed off basic sediments and water. Such pits are normally fenced for protection of livestock and wildlife.

Water Treatment and Injection Facilities - Secondary recovery of oil reservoirs in Oklahoma is done primarily by water flooding. In general, surface facilities may consist of a combination of (1) tanks for storage and treatment of water produced with the oil production, (2) a water supply well, (3) aeration and/or sedimentation ponds, (4) chemical treater, (5) a filtering system, (6) clear water storage, (7) injection pumps, (8) metering system, (9) an injection well.

The abandonment phase begins near the end of the production phase, or when production is too low to pay operating costs. As production declines and secondary recovery involving water injection progresses, some wells begin producing high volumes of water and they are ususally shut in or abandoned.

When production reaches the point where oil or gas can no longer be recovered economically, the operator requests permission from the USGS to plug and abandon his well or wells. The operator must submit an abandonment plan outlining the proposed procedure. The Oil and Gas Supervisor determines if it is in the interest of conservation to allow abandonment or if additional resources can be recovered by any known techniques (See Attachment #5). The abandonment must provide for restoration and rehabilitation

of disturbed soil and resources as provided for in the lease stipulations. The BLM is contacted for recommendations as to the necessary surface restoration methods. Much of the gathering system flow lines and other buried pipe will be left in place as the cost of removal will exceed the salvage value.

If the lease is relinquished or expires, the Bureau of Land Management must prepare a report either accepting the rehabilitation as adequate or rejecting it and outlining any problems or deficiencies. The lease bond is terminated only when the BLM and USGS are satisfied the lease stipulations have been complied with.

B. Alternatives

The cessation of oil and gas leasing is the only alternative. This decision would require an eventual drastic reduction in the American standard of living or a turn to alternative energy sources. A partial list of sources is as follows:

a. Increased oil imports

b. Increased onshore oil and gas production

c. Increased OCS production

d. Increased nuclear power

e. Increased use of coal

f. Increased hydroelectric power

g. Oil shale production

h. Well bore stimulation for recovery from known deposits

i. Synthetic natural gas and oil

j. Increased gas imports

k. Geothermal

These alternatives are beyond the scope of the EAR. However, they are covered in detail in the following documents:

--Final Environmental Statements FES 73-19; Proposed 1973 Outer Continental Shelf East Texas General Oil and Gas Lease Sale

--Programmatic Environmental Statement, Upland Oil and Gas Leasing (currently in draft).

--Energy Alternatives Document (currently being prepared by the Department).

II. DESCRIPTION OF THE EXISTING ENVIRONMENT

A. Existing Environment

1. General Description of the Planning Unit

a. Non-Living Components

Air

Air movement and the climate of Oklahoma is greatly influenced by the continental air mass to the north and the humid Gulf area to the south. Predominant air masses during late December through February are the continental polar air and accompanying northerly winds from Canada. Throughout the rest of the year the predominant air mass is the humid tropical air and southerly winds that originate in the Caribbean Sea and the Gulf of Mexico. The climate of the state is primarily controlled by the movement of air across the continent from the northwest, although air from the Gulf dominates the moisture patterns.

Generally throughout the state the wind direction is from the south in the summer and from the north during the winter. Average yearly wind velocity ranges from 8 to 14 miles per hour, with stronger velocities of 25 to 40 miles per hour being recorded during the late winter and spring months. High winds and tornadoes of varying degrees frequent the area during the spring and early summer, as do hail and thunderstorms.

The topography of the unit is flat to rolling in the west with occasional buttes and rough drainage patterns. The eastern one-half is rolling to semimountainous. Oklahoma is predominately part of the Great Plains, but does have four low elevation mountain ranges; (1) the Ouachitas in the southeast, (2) the Arbuckles in the south-central, (3) the Ozarks in the northeast

and (4) the Wichitas in the southwest. Other topographic regions in Oklahoma are shown on Attachment #2. The highest elevation in Oklahoma is 4,975 feet above sea level and is located in the extreme northwest corner of the Panhandle. The lowest elevation is in the southeast corner at 305 feet above sea level.

Generally, the state has a bright and clear climate with precipitation varying from 15 inches in the Panhandle to 55 inches in the southeast and averaging approximately 34 inches for the state as a whole. Climatic conditions in the unit ranges from dry in the west through sub-humid to humid in the east. The seasonal variation in precipitation is as follows:

> Spring, the wettest season, receives 33 percent of the total; summer 27 percent; fall 25 percent; and winter 15 percent. May is the wettest month having approximately 15 percent of the total.

Temperatures vary from below freezing in the winter to more than 100 degrees in the summer. The state's average maximum annual temperature is 60.5 degrees. The growing season ranges from 180 days in the Panhandle to 240 days in the southeast.

There are no known human related activities in the state that adversely affect the air movement or temperature. Consequently, there is no adverse effect on the naturally existing or subsequent succession of biological communities.

Pollution of the air occurs primarily from wind action on exposed or disturbed soils. These soil particles in the air result in dust storms of various magnitude depending on velocity of the wind. Contributing to dust pollution are activities such as farming, feed lots, construction, mining and oil and gas operations. Farming is undoubtedly the biggest contributor to this type of air pollution. In the past, Oklahoma was on the perimeter of the dust bowl, but marginal farm lands have been restored to native vegetative cover and improved farming methods have helped to effectively reduce dust storms.

Other particulate matter resulting from industry is slight, since Oklahoma is not highly industrialized.

Air pollutants such as carbon monoxide, hydrocarbons, nitrogen oxide and sulfur oxide occurs as smog in the more heavily populated and industrialized areas. These areas are primarily Oklahoma City and Tulsa with some being present in and around other communities depending on size and industrial activity. There are smog and unpleasant odors which originate with vehicular traffic. The oil and gas industry contributes a moderate amount of pollutants from burning and use of hydrocarbons during exploration activities, production phases and subsequently the refining process.

Most smog and other individual air pollutants are moved and disbursed by the relatively constant wind action. At times during low pressure situations or inversions, various pollutants combine to form a smog that is held in specific localized areas.

Noise pollution is present in varying degrees throughout the state. Primarily, noise is the result of operating machines such as the automobiles, heavy equipment, (mining, construction, farming, etc.) oil and gas operations (including refining) and other various people oriented activities.

Land

Brief Geologic History of Oklahoma - Rocks of every geologic period crop out in Oklahoma. Although most of these rocks are of sedimentary origin, consolidated from sediments deposited during the Paleozoic Era, the oldest are Precambian granites and rhyolites formed 1.35 to 2.05 billion years ago. Precambrian and Cambrian igneous and metamorphic rocks underlie all of the state and are the floor or "basement" upon which all younger rocks rest.

At many times in the past, forces within the earth caused portions of Oklahoma and surrounding states to alternately sink below and rise above sea level. When the region sank, large areas were covered by shallow seas, and thick layers of marine mud, sand, and calcareous skeletal debris were

deposited. When certain areas were later raised out of the seas, earlier deposited sediments and rocks were exposed and eroded, just as they are being eroded today. Uplift was accomplished either by gentle arching of broad areas or by the formation of mountains where rocks were intensely folded and faulted and thrust upward.

The three principal mountain belts of Oklahoma -- the Ouachitas, Arbuckles, and Wichitas -- occur in the southern third of the state and were formed by folding, faulting, and uplift during the Pennsylvanian Period. North of the mountain uplifts are two deep basins (Anadarko and Arkoma), and north of these basins are the relatively undisturbed shelf areas of northern Oklahoma.

During the Mississippian and Pennsylvanian Periods, the sedimentary basins of Oklahoma sank much deeper and more rapidly than before. Thick sequences of shale with interbedded sandstone and limestone were formed in these basins and also in a deep basin that existed in the area of the present Ouachita Mountains. Plants growing in swamps near the edge of Pennsylvanian seas were buried and have since decomposed to form coal or other hydrocarbons.

Following the period of mountain building, a shallow Permian sea covered western Oklahoma. The mountains were largely worn down, and sand and mud eroded from land in the eastern half of the state were carried in rivers to the sea. The red color of these Permian sandstones and shales comes from red iron oxide compounds deposited with the sand and mud. The climate was warm and dry, and thick layers of gypsum and salt were deposited from evaporating sea water.

Nonmarine shales and sandstones characterize the Triassic, Jurassic, and Cretaceous sedimentary rocks of Oklahoma. Shallow seas covered southern and western Oklahoma during some of the Cretaceous Period, and marine deposits resulted in limestone and shale.

Since the broad gentle raising of Oklahoma and surrounding areas above sea level at the beginning of the Tertiary Period, no part of the state has been covered by sea water. Oklahoma's land surface sloped down to the east and southeast, and extensive deposits of Tertiary sand and gravel were washed in by large rivers flowing from the newly formed Rocky Mountains.

The Quaternary Period, up through the present, is characterized as a time of erosion. Rocks and loose sediment at the surface are being weathered to soil, and the soil particles are then carried away to streams and rivers. In this way hills and mountain areas are being worn down, and sediment is carried to the sea or is temporarily deposited on the banks and in the bottoms of rivers and lakes.

Present day topography and landforms are largely controlled by the kinds of rocks at the surface. Resistant rocks, such as granite, sandstone, and limstone, generally form high ridges, hills, and mountain peaks; whereas nearby outcrops of shale and other easily eroded rocks form valleys and lowland areas.

Soils of the state vary considerably but are mostly sedimentary in origin. Soils range from rich bottom land to sandy hillside loam. The prevailing soil is a dark red loam, made up of decomposed sandstone and limestone; the river valleys often have rich deposits of alluvium. In the southeastern part the soils are often rocky in contrast with central Oklahoma where the soils are clay and sand. In the western portion, sandy to sandy clay loam soils predominate. Dispersed throughout the eastern part of the state along drainages, river bottoms and valley bottoms are the deep rich soils that result from alluvium deposits. Along the the major drainages in the western portion these bottoms are more sandy in character.

Soil depth and structure becomes better developed from west to east across the state as a result of increased precipitation and vegetative cover.

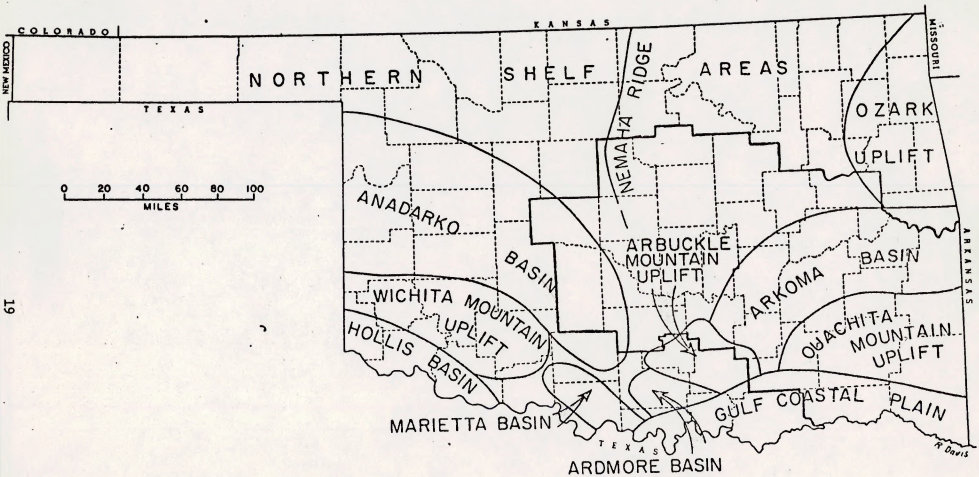


Figure 2-2. Major geologic provinces of Oklahoma (from Johnson and others 1972).

Man has had considerable influence on the soil depth, structure, nutrients and pollutant properties.

Poor farm and ranch management is a primary factor in the reduction of the productive soil depth as well as adversely affecting the soil structure in some areas of the unit. Modern technology and improved farm and ranch methods are helping to alleviate this problem. Oil and gas, construction, mining, and timber activities contribute their proportionate share to the above situation.

Pollutants are added to the soil in the form of fertilizers, herbicides, pesticides, petroleum residue, indiscriminate dumping of solid waste, sewage seepage, livestock fecal droppings, irrigation and runoff waters, and various industrial chemicals. Agriculture, oil and gas, mining, and many other human activities result in some form of soil pollution or disturbance.

Nutrients in nature are used and replaced in varying degrees. Farming has the most dramatic affect on the nutrient factor.

The geologic structure has no doubt been adversely affected to some undetermined extent as a result of past and present oil and gas activities, strip and shaft mining, water well drilling and various other industrial activities.

The land use compatibility and suitability throughout the state is well meshed, with no particular problems. Those activities causing surface disturbance and pollution (air, land and water) are the least compatible and suitable. Oil and gas activities would have to lead the list causing these disturbing factors, since it is the states biggest industry and has been for many years. Oil and gas wells have been developed extensively in practically every county, this with the accompanying network of roads, pumping facilities and refineries is

a disturbance of high magnitude. Moisture and soil conditions are such that rehabilitation work has been generally effective and has tempered the permanency of this situation. Mining and logging are second and third in this respect and although the area disturbed is less, the restoration process is considerably prolonged.

Other main uses of the land which seem to exist in relative harmony are recreation, agriculture, transportation systems, communities (rural and urban), business and industrial establishments, wildlife and all associated facilities.

The present environment seems to be in near balance with the land use demands. Continual disturbance from any sources without proper protective stipulations would no doubt result in a downward trend of the environmental qualities.

Water

Water in Oklahoma as in most other localities is a valuable and needed resource.

Precipitation is the primary source of all surface water and virtually all ground water within the state. Part of the precipitation falling on the land surface runs off to form streams and rivers and to fill lakes and ponds, the remainder either evaporates or soaks into the soil and eventually enters the underlying water table.

The two largest rivers in Oklahoma are the Arkansas and Red. The latter flows along the state's southern border, the former in the northeast portion. These two rivers and their tributaries drain the entire state. Other large streams and rivers flowing into the two main rivers are the Illinois, Grand, Verdigris, Poteau, South Canadian, North Canadian, Cimarron, Salt Fork of the Arkansas, and the Washita. On many of the larger rivers, dams

have been constructed as sources of hydroelectric power irrigation water, municipal-industrial supplies, flood control, navigation and for recreation. Twenty-nine major federal reservoirs are located in the state ranging in size from 890 to 102,500 acres, with a total shoreline of 5,225 miles. There are another 1,777 smaller lakes with surface acres of 10 or more and 189,579 ponds with areas of less than 10 acres.

Most drainages in the state maintain intermittent pools of water during rainfall runoff periods.

A shallow water table is indicated in most river bottoms. Generally, ground water may be found in water aquifers of sandstone, limestone and loose sand and gravels along major rivers and live streams.

Water may be found at depths of 50 to 150 feet below the surface, depending on the distance from these drainages (rivers and stream beds).

All ground water contains various minerals dissolved from rocks that water moves through. The mineral content of ground water in the state varies from low to high with much of it being suitable for most purposes. Highly mineralized water, unfit for any use is present beneath the fresh water at depths of from 150 to 700 feet.

Throughout most of the unit the rocky, sandy loams and sandy clay loam soils have a good vegetative cover and a high infiltration rate resulting in relatively low runoff rates.

Approximately 90 percent of the moisture comes in the form of rain. Sixty percent comes during spring and summer which is the growing season. The quality of the precipitation is good due to lack of particulate matter in the air.

Surface runoff during moderate precipitation periods is no problem because of the: 1) relatively flat to rolling terrain, 2) good vegetative cover and 3) high infiltration quality of the soil. Some erosion and flooding occurs periodically from high intensity storms or a combination of frequent rain storms. During these heavy runoff periods, heavy silt loads are present. Some surface water is naturally polluted by certain chemicals and salts in the soil as the water passes over. Other contaminating material is also added along the route.

As stated previously, ground water is readily available with the recharge of the aquifers fairly well balanced. These waters are affected by the same naturally dissolved chemicals as surface water.

Considerable evaporation and transpiration takes place due to the many surface acres of water and the heavy vegetative growth.

Agriculture contributes fairly high quantities of pollution into the surface and ground waters by irrigation, added fertilizers, feed lots and crop spraying. This is in the form of coliform bacteria, salts, chemicals and sediments.

Since Oklahoma has only light industry and therefore produces only small amounts of polluted effluents there is no particular problem at this time, but the probable expansion of Oklahoma City and Tulsa's industrial base assures increased activity in the near future.

Water pollution related to the production and refining of oil and gas has been an occasional problem throughout the state. Early-day practices of allowing the salt water produced with petroleum to flow freely on the surface and into streams had an adverse effect on local soil, vegetation and aquatic life. Also some of the abandoned wells drilled many years ago were

poorly plugged, sealed or cased (some were merely left as open holes) and petroleum or salt water has seeped out of the hole to contaminate the fresh ground water or has flowed onto the surface of the land. This is still occuring and has left its mark on the water quality in certain areas. Occasionally, chemicals or petroleum products or by-products are accidently discharged from wells, gathering lines, separating units, or oil and gas refineries; such discharges have a minor to serious effect on the local environment, depending upon the size and composition of the discharge.

Some rural and municipal seepage of sewage and solid waste is no doubt present in varying degrees.

The surface and ground water throughout the state is relatively uncontaminated except where local conditions present certain problems.

b. Living Components

Oklahoma produces more than $1.1 billion annually in crops and livestock. The 89,000 farms and ranches embrace more than 37,100,000 acres, with over 15.7 million acres in crop land. The average farm is estimated at 417 acres compared to 163,000 farms with an average of 230 acres per farm 25 years ago. Soils range from rich bottom land to sandy hillside loam. Cattle and calves, small grains, dairy products, poultry, other livestock, peanuts, cotton and grain sorghum produce most of the state's agricultural wealth. Truck farming, broomcorn, soybeans, pecans, and other crops add to the financial return. Livestock represents more than 75 percent of the agricultural income. Oklahoma ranks 7th nationally in income from cattle and calves but 5th nationally in number of head. Oklahoma, with over 2.2 million head of beef cows, is second only to Texas in beef cow-calf type ranching operation. The largest cash crop is winter wheat ranking 4th nationally. Some years the value of this crop has exceeded $200 million. Hay is second to wheat in cash value of production, exceeding $89 million in 1971, but for cash income peanuts and cotton lint and seed rank above hay. Oklahoma's cattle industry was valued in excess of $1 billion on January 1, 1972.

The Department of Wildlife Conservation manages Oklahoma's wildlife population. Four big game animals are found in Oklahoma. Whitetail deer are found in all 77 counties, and Rio Grande wild turkeys are hunted in a major portion of the state. Pronghorn antelope inhabit the Panhandle area. Elk are present in the Wichita Mountains Wildlife Refuge and have been introduced in eastern Oklahoma. Among smaller upland game, squirrel, rabbits and quail are plentiful, with migratory birds such as dove, ducks and geese abundant during their annual autumn migrations. Statewide, bobwhite quail is the top game bird, and Oklahoma is one of the top quail producing states in the nation. Ringneck pheasant and prairie chicken are hunter's favorites in the fall. The native sport fish species in the state are the largemouth, smallmouth and spotted bass, channel, blue and flathead catfish, white bass, crappie and sunfish. Several exotic species, such as the striped bass, walleye, northern pike, and rainbow trout are proving a boon to the state's fishery.

Vertebrates which are or were formerly a part of Oklahoma's native fauna and which are officially listed as endangered on the list published in the May 19, 1972 edition of the Federal Register. These include: whooping crane (Grus americana), southern bald eagle (Haliaeetus lencocephalus), ivory billed woodpecker (Campephilus principalis), red cockaded woodpecker (Dendrocopos borcalis), American peregrine falcon (Falco perigrinus anatum), Eskimo curlew (Numenius borealis), Indiana bat (Myotis sodalis), black-footed ferret (Mustela nigripes), and red wolf (Canis rufus).

Oklahoma vertebrates not included on Official Endangered Species List (Federal Resistes), but considered by the Office of Endangered Species to be so few in number or so threatened by present circumstances as to be in danger of extinction. These species include: tule white-fronted goose (Anser albifrons gambelli), prairie falcon (Falco mexicanus), northern greater prairie chicken (Tympanuchus cupido pinnatus), lesser prairie chicken (Tympanuchus pallidicinctus), Ozark big-eared bat (Plecotus townsendii ingens), leopard darter (Percina pantherina), Arkansas darter (Etheostoma cragini). The latter is not included in the Federal Register, but is considered by some authorities to be

endangered. Other species include: white-faced ibis (Plegadis chihi), wood ibis (Mycteria americana), western snowy plover (Charadrius alexandrinus nivosus), mountain plover (Eupoda montana), northern long-billed curlew (Numenius americanus parvus), ferruginous hawk (Buteo regalis), American osprey (Pandion haliaetus carolinensis), Eastern pigeon hawk (Falco columbarius columbarius), prairie pigeon hawk (Falco columbarius richardsonii), western burrowing owl (Spectyto cunicularia hypugaea), Black-capped vireo (Vireo atricapilla), Texas kangaroo rat (Dipodomys elator).

Little information is available on those species listed except for approximate numbers and use locations. It is sufficient at this point to suggest that the existence of these species is recognized and that mitigation of impacts derived from oil and gas activities will be directed to these wildlife species first.

Due to the wide diversification in wildlife habitat in Oklahoma, an understanding of the character and extent of these conditions today is essential. Oklahoma is so situated within the nation as to enclose that portion of the continent where the eastern forests merge with the prairies and the plains of the west. This is reflected in the presence of game species typical of both the eastern forests and the western grasslands within the confines of the states.

The game type map of Oklahoma, Duck and Fletcher (1943), (see page #39) is a result of actual field mapping correlated with the prior studies concerning vegetation, geology, soils, climate, and land use in relation to game populations and is insufficient detail for wide application in habitat evaluation.

Game habitat conditions have been classified under 3 general headings. A total of 12 habitat types has been defined within the state of which 5 are forested, 4 are shrub-grassland and 3 are agricultural-grassland types.

Forested Type

1. Post oak-blackjack
2. Bottomland
3. Oak pine
4. Oak hickory
5. Loblolly pine-hardwood

Shrub-grassland Type

1. Pinon-juniper mesa
2. Sand sage grassland
3. Shinnery grassland
4. Stabilized dune

Agricultural-grassland Type

1. Tall grass prairie
2. Mixed grass-eroded plains
3. Short grass-high plains

A state-wide picture of game environment is important to those whose responsibility is to plan and administer the land resources. The present game map makes possible the calculation of total habitat type necessary to any particular game species in a relatively short time. It is also possible to obtain a clear picture concerning the present and future of most any species if the map and associated information are carefully considered.

Post Oak Blackjack Game Type - This type (17,600 square miles) represents a forest-grassland ecotone and contains dominates from both the deciduous formation and the grassland formation.

The overstory is largely composed of post oak (Quercus stellata), blackjack oak (Q. marilandica), and black hickory (Carya buckleyi), with the percent of blackjack oak increasing in the composition to the west throughout the type. The understory is made up of little bluestem (Andropogon scoparius), big bluestem (A. furcatus), and other species depending on the sites. This type is usually associated with deep sandy quaternary soil.

This game type, as found through the cross timbers agricultural region of the state, presents some of the most serious problems of sheet and gully erosion in the country. The result is that the productivity of the land as a game producer as well as a human producer has been seriously reduced.

The wildlife characterists of this type offers more in the way of farm game management possibilities than the other types. Improved farming methods result in better small game habitat. The principle species are bobwhite quail, fox, squirrel, and cottontail rabbits. Whitetail deer are found scattered throughout the type. Furbearers although locally low are fully represented here. For the bulk of the type, marginal conditions such as railroad rights-of-way, county road margins, field edges and prairie wood margins account for the main part of the small game habitat. In the center of the wooded area quail are abundant only when the soil disturbances have brought about a variation in the vegetation.

For the most part, game populations particularly bobwhite, quail, and cottontails are not in need of serious attention in the northwestern portion of the type. The remainder, however, could support a much larger quail population than it does at the present (because burning and heavy grazing result in more serious distruction of game habitat than in the northwest). The soils here are either naturally poor or poor through depletion and fenced areas often do not show an immediate development as they should. Fertilization is often necessary to restore the vegetation.

Potentially the post oak blackjack game type condition is a good game and fur producer and because of its large size it warrants serious attention. Practically all large human centers of population east of El Reno are either within or

near the type and it probably supports the heaviest hunting pressure than any other type.

It must be emphasized that the game increase of this type is an agricultural problem and must be attacked through cooperation with farm agencies and local sportsmen, garden clubs, etc.

The Oak Hickory Forest Game Type - (3,713 square miles) is located largely in the northeastern portion of the state and includes highlands or the Ozark Mountains. The type is bounded on the west by the Grand River.

The type is characterized by a vegetation comprised of such species as blackjack oak, post oak, red oak (Quercus rubra), pin oak (Quercus palustris), black oak (Quercus velutina), white oak (Q. alba), black hickory, scaley bark hickory (Carya laciniosa), pig nut hickory (C. glabra), and winged elm (Ulmus alata). The ground cover is composed of a mixture of huckleberry (Vaccinium vacillans), coral berry (Symphoricarpos orbiculatus), sassafras (Sassafras spp.), big bluestem, spice bush (Benzoin aestivale), bladdernut (Staphylea trifolia), hazel-nut (Corylus spp.), may apple (Pedophyllum peltatum), bloodroot (Sanguinaria canadensis), and grape (Vitis aestivalis).

Because of its rugged topography only 30 percent of this type has been cleared for agricultural purposes and around 70 percent still stands as woodland. However, because of the diversified crop production and small fields, the woody nature of the type results in satisfactory small game production.

The field and timber margins here are the principle producers of the small game species such as bobwhite and cottontail rabbits (populations run relatively high). The more rugged mountainous country is the producer of those species which desire more undisturbed habitat, such as deer, fox and gray squirrel. It is estimated that this condition could support around 50,000 deer alone. Wild turkey and rare fur-bearers

may be increased throughout the type. The type, as a whole, offers excellent opportunities for the restoration and increase of all game species existing, as it is in larger areas of forests and small field agriculture.

Bottomland Timber Game Type - (3,400 square miles) includes the bottom and stream course of all the regular drainages of the state. Due to its state-wide consideration there is much variation in the plant composition. In the Panhandle and western counties much of the bottom acreage is devoid of larger permanent vegetation. In places buffalo grass, blue grama, Johnston grass and river grass form the dominate plant cover. Scattered growths of cottonwoods are common with a few willows and hackberry. Elms are more common throughout the central west. Typical stream growth in central Oklahoma within the Tall Grass Prairie Type consist of American elm, Chinquapin oak, post oak, blackjack oak, hackberry, chittum wood, cottonwood, chickasaw plum, fragrant sumac, smooth sumac, and rough leafed dogwood. Black oaks, pecan, sycamore, bitternut, and walnut are more common southward and eastward.

Because of differences in rainfalls and other factors both the luxuriance of growth and the number of plant species increase from west to east along the principle east west streams. In the southeast corner of the state along Little River, Mountain Fork River and their tributaries, bald cypress (Taxodium distichum), sweet gum (Liquidambar styraciflua), sour gum (Nyssa sylvatica), as well as white oak, willow oak and water oak, wards willow, buttonbush, alder, mulberry and American holly are the principle trees. In the northeastern section of the state where there is about the same amount of rainfall, the sweet gum, sour gum, willows, American elm, sycamore, hickories, hackberry, white oak, water oak, willow oak and red oak are more common.

The bottomland type in Oklahoma occurs chiefly in long, narrow and irregular strips. This type occurs in every county of Oklahoma and on all major streams. It differs from other timber types of the state in that most of the bottom soils are extremely fertile and deep (alluvial in origin). In some areas saline deposits are present particularly associated with the Cimarron, Salt Fork of the Arkansas and Salt Fork of the Red Rivers.

Climatic characteristics cannot be treated separately for this type since it is found within every type discussed already. Small game populations of this type suffer much from the seasonal floods in the western part of the state where the only available cover is found along the streams. However, this is not the case over a large part of the state where good cover conditions adjoin the bottomland type.

Cultivation of this type increases from west to east through the entire state. Farming is the principle industry of the type and grain sorghums, wheat, oats, vegetables, alfalfa, corn, cotton and native meadows form the bulk of the crops.

Generally, game populations are high throughout the type for habitat conditions are good. In many of the better agricultural bottoms along the Arkansas, Red and Washita Rivers game populations are extremely low due to a deficiency of year round cover. This land is cultivated so intensely that very little area is allowed to grow up into the desired weedy and brushy cover.

This bottomland type offers some of the better game habitat conditons in Oklahoma and is capable of supporting many different species. The more common game species are as follows: bobwhite quail, squirrel (both gray and fox), cottontail, pheasants and such fur-bearers as raccoon, opossum, skunk, mink, muskrat and beaver. The bobwhite quail, squirrel and the furbearers -- raccoon, mink, muskrat and beaver are the major species that restoration projects should be concerned with in this type.

The Oak Pine Forest Game Type - (4,992 square miles and 120 square miles of loblolly pine) occupies the rugged Ouachita Mountain region in southeastern Oklahoma. Throughout most of the type shorleaf pine (*Pinus echinata*) is found in a mixture of various oak and hickories and, in some areas, rather extensive pure stands of the pine are found. Included within the discussion here are about 120 square miles of the Loblolly Pine-Hardwood Game Type in southeastern McCurtain County.

The more common trees of the combined types are shortleaf yellow pine (Pinus echinata), loblolly pine (Pinus taeda), white oak, blackjack oak, post oak, spotted oak (Quercus shumardii), willow oak (Quercus phellos), black locust (Robinia pseudo-acacia), black hickory, basswood (Tilia americana), and sugar maple (Acer saccharum). Huckleberry (Vaccinium vascillans var. crinatum), mockorange (Philadelphus pubescens), pink azelia (Rhododendron roseum), gooseberry (Grossularia spp.), bladdernut (Staphylea trifolia), and spice bush, are the more common forbs and shrubs. Big bluestem is common over the entire type particularly the drier portions.

Due to the generally infertile soils and rugged topography, only around 15 percent of this type is in farms. Only 11 percent is in actual crop production and the rest is in woodland. Timber harvest, coal mining, and farming are the principle land use activities.

Agriculture must be treated as a permanent land use and perhaps a somewhat stable one if compared to farming operations in the western section. Here cotton is the principle cash crop and considerable corn is grown for both cash and grain.

Lumbering has been the greatest factor of mans activity influencing game populations. Cutting of the timber has opened up timber stands and allowed dense undergrowth to develop. Early literature clearly shows that the present day bobwhite populations are definitely above those of the days before timbering. Habitat has been improved for deer and other species, but other factors operating has kept these from showing the increase seen with the bobwhite quail.

The major part of this type has been cut for timber and the second growth is making good game cover. An excellent opportunity is offered here for the restoration of many important game and furbearing species. The major portion of the state's deer population and the only remaining native wild stock of wild turkey are found here. Bobwhite quail, cottontail rabbits, spotted skunk, and opossum are found mainly around the small farms and clearings.

Deer, wild turkey, raccoons and fox are found in the wilder portions. Here the fox squirrel occupies the mountains and ridges while the gray squirrels are found on the bottomland.

The Tall Grass Game Type - (20,500 square miles - central, northeast Oklahoma) occupies most of the best of the agricultural soils of Oklahoma and, with the exception of the Arbuckle Mountain and Osage areas is characterized by clean cultivation and low game potentiality. On the basis of original vegetation this type includes the big bluestem subtype, the little bluestem subtype and probably a portion of the eastern edge of the mixed grass ecotone type.

For the most part the natural vegetation consist of a mixture of such species as big bluestem, little bluestem, Indian grass, (*Sorghastrum nutans*), switch grass (*Panicum virgatum*), and silver beard grass in the eastern portions of the type, with a gradual increase of such species as buffalo grass (*Buchloe dactyloides*), blue grama (*Bouteloua gracilis*) and side oats grama (*B. curtipendula*). Continued grazing has removed the tall grass species from the composition of the western portion of the type leaving only the short grasses.

As a result of fertile soils, generally sufficient rainfall for small grains, and favorable topography, tall grass game type is essentially agricultural game habitat. With the exception of the mountainous areas, the type west of the cross timbers is approximately 80 percent cultivated. Throughout this portion of the type, wheat is a principle crop in the north while cotton ranks first in the south. Corn is a ranking crop in the northeastern portion with hay a close second. The old sage grasslands are used very little for crop production, but largely for pasture.

Farm tendency for the tall grass game type from north to south across Oklahoma is around 35 percent in Garfield, 49 percent in Craig county, as compared to 60 to 70 percent in parts of southern Oklahoma.

Most of the wildlife of this type is confined to the stream border cover which has in most cases been mapped as bottomland forest type. However, the badger, striped skunk, greater prairie chicken and coyote are the principle species

utilizing the true tall grass uplands. Throughout the northern portion of the type west of the central cross timbers, little is offered in game cover. However, eastward and southward better cover and relatively high populations of small game are found. Johnston grass has become important for bobwhite where it has not developed too rank a growth.

The Mixed Grass Eroded Plains Game Type - includes some 85 hundred square miles generally located across the western one fourth of the state excluding the Panhandle counties. A mixture of both tall and short grass species characterizes the original vegetation pattern with variation in the composition on the western and eastern edges where this type merges into the other two associated grasslands. This game type is characterized by a mix grass composition and a definite ravine relief which is generally wooded. It is part of an extensive area of similar vegetational condition which overlaps into the tall grass species from the east and short grass species from the west. In the southwest part of the state, extensive areas are covered with mesquite. Scale quail were once found in the southwest portion of this game type in large numbers.

The flat lands of this type is about 70 percent under cultivation, while the rough broken land is probably not more than 10 to 15 percent in cultivation.

Snow and rain is of importance here, seriously affecting such game species as bobwhite and mourning doves. The snows usually occur late in winter after the winter foods have been seriously depleted. Since most of the cover is located in ravines and bottoms, sudden floods and deep snows are detrimental. Drouth periods are serious throughout the type in preventing the development of sufficient protective cover and sometimes winter food. However, bobwhite quail (coveys) are adapted to the lack of water since they are often found 2 to 3 miles from water holes.

The composition of the vegetation consists of short grass species, buffalo grass and blue grama with side oats grama abundant in places. Little bluestem is an important species where moisture is sufficient and grazing not excessive.

Principle game species found within this type are mourning doves and bobwhite quail. Cottontails are abundant along

stream borders and jack-rabbits and coyotes offer much sport to those running hounds. Furbearers are abundantly representative only in that section of the wooded ravines. Raccoon and minks are extremely scarce throughout.

Bobwhite populations indicate definite seasonal shifting. Studies indicate that birds nesting on the uplands move to the canyons or better adjacent types for the winter months. This often results in local concentrations and sometimes in serious loss. Lesser prairie chickens were once found in abundance on the type, particularly where it adjoined some of the sandy grasslands. It is doubtful that even under the most moderate grazing pressure they could establish themselves here again because almost any use destroys the taller grasses and cover which seems essential to their survival.

The widespread establishment of farm ponds throughout this type offers much in a way of game habitat improvement.

A Stabilized Dune Game Type - (668 square miles includes the heavily vegetated sand dunes which occur on the north sides of the Cimarron and North Canadian Rivers in northwestern Oklahoma. The type is recognized by most ecologists as constituting a separate animal environment.

The type is characterized by distinct dune-like relief covered with an excellent variation of trees, shrubs, grasses and weedy annuals. Such species as American elm, hackberry, chittum, post oak, blackjack oak, form most of the overstory. Associated with this group are the wild grapes, sand plum, dogwood, skunk bush, sumac and such tall grasses as are typical of these western sandy soils.

The dune-like relief usually forms a pattern of alternating rows of dunes and valleys that run parallel to the associated rivers. Wildlife take advantage of this feature particularly during prolonged cold and wet periods. What little cultivation is found here is confined to very small fields of grain sorghums between the dunes on tired soils. The greater use is for grazing. In recent years, goats and sheep have been introduced here, resulting in an extreme local overgrazing particularly in the case of goats. When the brushy vegetation is destroyed, the sand is allowed to blow and eventually results in sizeable areas of worthless land.

This is the best game type of western Oklahoma, it consistently supports some extremely high bobwhite populations. Cottontail rabbits and fox squirrels are generally abundant. Furbearers are well represented and whitetail deer are found in very small numbers throughout the type.

Bobwhite quail often concentrate here coming from surrounding types during severe weather and late winter. It appears that much of the wintering population is produced on the adjoining uplands.

The Shinnery Grassland Game Type - (1,173 square miles) in the western counties represents the eastern edge of a similar habitat type found through portions of the Texas panhandle and eastern New Mexico. The habitat type is characterized by a low growth of several species of oak intermixed with the tall grasses of the western sandy areas. At present little bluestem predominates. Shorter grasses, however, come in on tighter soils.

Principle crops in the North are grain sorghums, grain corn once ranked high here. In the South, cotton comes into its own importance, particularly in Beckham and Harmond County.

Generally, this type is a good game producer in spite of its relative instability. The principle species are lesser prairie chicken, bobwhite quail, cottontail rabbit and mourning dove. Whitetail deer and wild turkey are found along a few of the stream bottoms. However, the turkey and most of the deer are the result of introductions. Deer appear to be increasing in the past few years particularly in the vicinity of Washita River and Roger Mills County.

Game cover for small game species is greatly improved in this type by the small field agriculture practiced, which provides excellent marginal conditions. On moderately used lands the roadsides, field margins and fence rows support excellent game populations. Blowing sand collects on the east-west roads and fences for bobwhites and cottontails. There is a definite seasonal shift of bobwhites from upland nesting grounds to bottomland and farmland winter cover on this type.

The Sand Sage Grassland Game Type - (2,600 square miles) include all of the sandy grasslands on which sand sage (Artemisia filifolia) forms an important part of the ground cover. The type is found throughout the northwestern part of the state mainly on the north sides of the principle streams.

The characteristic plant species are sand sage, sand plum (Prunus spp.), skunk bush (Rhus trilobata), hackberry (Celis spp.), little bluestem, big bluestem, sandhill bluestem (Andropogon halli), and Indian grass. Grasses in this type are typical of the short grass plains area and are common on tighter soils. Retired fields and all marginal conditions support an abundant growth of weedy annuals and are usually in close association with weedy cover species.

Periods of drouth under the present land use have resulted in a serious depletion of game cover on the pasture lands particularly since grazing pressures are seldom decreased during these times. Wet seasons of 1942-1943 contributed much to a rapid recovery of the vegetation. Heavy snows, especially in the northwestern portion are often so intense that small game populations are seriously damaged.

From 40 to 50 percent of this type is in cultivation largely to wheat and grain sorghums. The remainder of the land is used for pasture land on which cattle are grazed.

The principle game species of the sand sage grassland type are the bobwhite quail, prairie chicken, mourning dove and cottontail rabbit. Scaled quail are found in the western Panhandle counties. Bobwhite commonly shift seasonally similar to that described for the other upland types within this part of the state.

This type offers some opportunity for effective game management in western Oklahoma. Often any soil disturbance results in abundant food production for small game, and the permanent cover of sagebrush, scattered plum and sumac makes excellent game habitat under moderate use.

The Short Grass High Plains Game Type - (1,127 square miles) is found mainly in the three Panhandle counties, Ellis county and the western portion of Harper and Woodward counties. For the most part, the type is restricted to higher tertiary materials throughout the state.

The original vegetation of the high plains type consisted mainly of buffalo grass, and blue grama, but in places bluestem, wire grass (Aristida spp.), and side oats grama occur. Other plants such as prairie clover (Psoralea tenuiflora), partridge pea (Charmaecrista spp.), blazing star, day flower, bush morning glory and gumweed appear on more shallow soils. In the wallows or sinks, smartweed, ironweed, doorweed and snow-on-the-mountain are found. Cultivated fields support Russian thistle, sunflower, cockle burr, lambs quarter, bindweed, ragweed and grassbur. Opuntia cactus has appeared as a result of close grazing on some pasture lands.

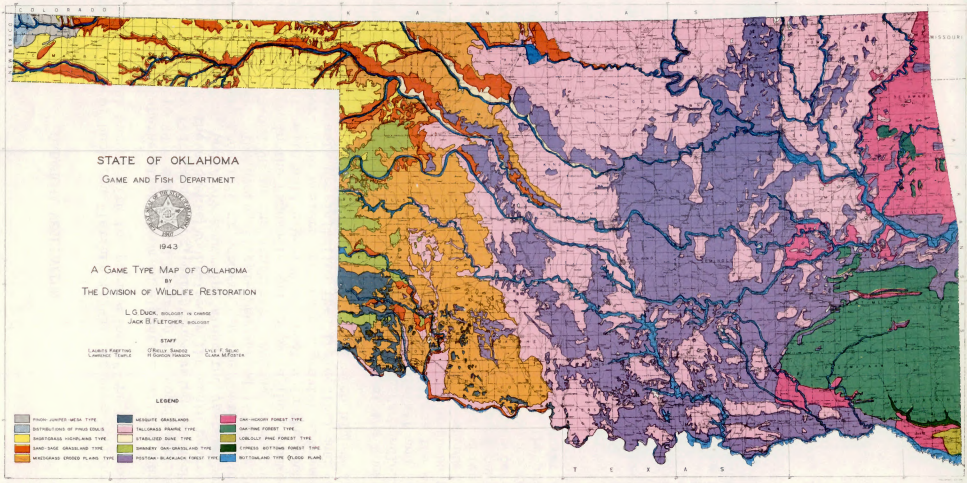
Wheat and grain sorghums are the principle crops throughout the entire type condition.

The more common game species include scaled quail, mourning dove and the New Mexico cottontail. Bobwhites are found along the dense cover of major streams where a variety of vegetation occurs. Pheasants and antelope are found on a short grass habitat type and seem to be increasing in good number. Some 30 antelope are at the present found on the type north of Keyes. Further investigations may show possibilities for increasing antelope populations on the type. Yet it is extremely unlikely that there will be a population sufficient to hunt.

Scaled quail seem to hold the greatest promise for restorative work in this area. However, shelter belts have greatly increased nesting sites for mourning dove.

The Pinon-Juniper Mesa Game Type - (363 square miles of which 87 square miles is the true pinon-juniper) is characterized mainly by the mesa-like topography and is limited in Oklahoma to the extreme northwest corner of Cimarron County.

The principle vegetation of the area is the pinon pine, however, (Pinus edulis), juniper (Juniperius monosperma), thick leaved hackberry (Celtis reticulata), Cholla cactus (Opuntia app.)


COLORADO
KANSAS
MISSOURI
TEXAS
STATE OF OKLAHOMA
GAME AND FISH DEPARTMENT
1943
A GAME TYPE MAP OF OKLAHOMA
BY
THE DIVISION OF WILDLIFE RESTORATION
L.G. DUCK, BIOLOGIST IN CHARGE
JACK B. FLETCHER, BIOLOGIST
STAFF
LAURITS KREFTING
LAWRENCE TEMPLE
O'REILLY SANDOZ
H. GORDON PANSON
LYLE F. SELKI
CLARA M. FOSTER
LEGEND
PINON-JUNIPER-MESA TYPE
DISTRIBUTIONS OF PINUS EDULIS
SAGEBRUSH HIGHPLAINS TYPE
SAND-SAGE GRASSLAND TYPE
MIXEDGRASS ERODED PLAINS TYPE
MESQUITE GRASSLANDS
TALLGRASS PRAIRIE TYPE
STABILIZED DUNE TYPE
SHRUBBY OAK-GRASSLAND TYPE
POSTOAK-BLACKJACK FOREST TYPE
OAK-HICKORY FOREST TYPE
OAK-PINE FOREST TYPE
LOBLOLLY PINE FOREST TYPE
CYPRESS BOTTOMS FOREST TYPE
BOTTOMLAND TYPE (FLOOD PLAIN)

OKLAHOMA VEGETATION

The original map of Duck and Fletcher (1943) has been reprinted by the Oklahoma Biological Survey with the permission of the Department of Wildlife Conservation.

The state slopes southeastward from an elevation of 1518 m at Black Mesa in the Panhandle to 99 m on the Red River in the southeastern corner. Topography is generally flat to rolling, exceptions being the Wichita Mountains in the southwest, the Arbuckle Mountains in the south central section, and the Ouachita, Boston, and Ozark Mountains along the eastern border. Mean annual temperatures vary from 15°C at Woodward in the Northwest to 18°C at Idabel in the Southeast. The average frost-free period is about 200 days at Woodward and about 240 days in the Southeast. Average annual precipitation varies from 38 cm in the Panhandle and 65 cm in the Northwest to 115 cm in the Southeast, with well over 130 cm locally in the mountains along the eastern border. The western section has greater extremes of temperature and more variable precipitation than the central and eastern sections. Wind velocities and evaporation rates are much higher in western sections than in eastern sections.

The Pinon-Juniper represents an eastern extension of the Rocky Mountain flora and is found only in the Black Mesa region of the Panhandle. The short-grass plains occur in areas of relatively low rainfall and are composed of blue grama, buffalo grass and other xeric species. Along the major rivers of the northern half of the state, there are numerous sandy areas and stabilized dunes which support sand sage, oaks and various shrubs. The western edge of the state is characterized by a sandy region which is covered with sand sage and islands of a taxonomically complex group of oaks, called oak shinnery. Most of the central part of the state is either covered with blackjack post oak forest or was once tall-grass prairie. Since the prairie soils are very rich and suitable for farming, virtually all the prairie has been converted either to grazing or crops. The oak forests cover areas of abandoned farmland or represent areas topographically unsuited for farming. The Ozark region is mostly deciduous forest dominated by a variety of oaks and hickories. The Southeast corner of the state is dominated by shortleaf pine or a number of deciduous tree species. Bottomland forests are characterized by such species as willow, cottonwood, elm, ash, hackberry, and sycamore.

In general, the grasses and trees become taller and larger from west to east and there are a greater number of species in the eastern part of the state. Although the state is dominated by tall grass and blackjack-post oak forest, there are representative vegetation types of the Rocky Mountains, high plains prairies, tall-grass prairies, Ozark hardwoods and coastal plain forests.

Oklahoma Biological Survey

Paul G. Risser, Director

and scrub oak (Quercus undulata) and western yellow pine (Pinus ponderosa) are found in limited areas.

The grasses found here are typical of the shortgrass high plains game type, consisting mainly of buffalo grass, blue grama, and hairy grama, (Bouteloua hirsuta), with some tall grass species growing on the slopes in places.

Very little of the type is in actual cultivation and the principle use is for grazing of cattle and sheep. Irrigation of the small valleys as well as that of the Cimarron has resulted in recent years in more cultivational flat lands.

Game species found on this type are scaled quail, blacktailed deer and New Mexico cottontail. Bobwhite quail and ringnecked pheasant are fairly common on the bottomlands associated with the mesa condition. Other animals fairly well confined to the type, but less commonly known over Oklahoma as a whole, are the hog-nosed skunk, porcupine and rock squirrel.

The area is so small that the hunting opportunity is small with the exception of scaled quail. However, there is the possibility that the area could be made into a state park. This should encourage the caring of other wildlife species since they are rather uncommon for Oklahoma.

c. Ecological Interrelationships

As in any action involving physical disturbance of a natural environment, oil and gas operations can and will produce chain effects on both the micro and macro ecological interrelationships such as nutrient cycles, hydrologic cycles, and energy flows. Specific impacts will vary greatly with the intensity of the operation. Basic to all requirements for animals is the need for energy. Thus, a satisfactory combination of food for growth, maintenance and reproduction must provide all of these essentials, in proper balance. Surface conditions have the most significant impact on ecological interrelationships as will be discussed under the Impacts Section.

Ecosystems of the planning unit, both aquatic or terrestrial, are very complex. The most diverse populations of wildlife with the most complex interrelationships thrive within the aquatic areas.

In the ecosystem of the Oklahoma Planning Unit, there are four basic energy levels which include: Nutrient sources, producers, consumers and decomposers (See Attachment #10 and 11).

Energy is transferred from one level to the next by the plants using water, minerals and sunlight to grow; by animals eating the plants; and by animals eating animals. The amount of energy transferred decreases from one level to the next as each level uses energy for growth and respiration. The energy used is not transferred, but lost to the next level.

Plants, insects, animals, birds all return to the energy source through the decomposers. All levels will return waste and dead organic matter to the land. Decomposers (bugs, worms, larvae) break down the dead matter into simple substances. This is then returned to the energy source and made available for reuse. Each plant, plant eater or meat eater is dependent upon the energy level preceding it for the special food, water and cover required by each species. The removal of any component (insect, plant, or animal) results in the loss (to the next level) of the energy contained in that organism. As a result, a population may diminish through a decrease in food supply. The ecosystem can be altered by removal of vegetation or rock ledges. The affected areas become uninhabitable to existing species so other plants, animals, etc. move into the area to replace them. Sometimes the replacement population is desirable or undesirable depending upon the value placed upon the existing situation. Therefore, surface disturbance can obliterate historic sites, decrease environmental qualities, and advance or retard natural succession by many thousands of years.

Water moves through an ecosystem in a different way from minerals. This movement of water from the ocean to atmosphere to land and back to the oceans is known as the hydrologic cycle. Water which reaches the soil may pass through and leave the ecosystem by way of springs, streams or underground channels.

d. Human Values

There is much evidence that primitive man existed in this area several thousand years ago. Various types of pottery shards and other Indian artifacts have been found throughout the state. Oklahoma has decendents from many Indian tribes now living in the state. Any state map shows many Indian names of counties, cities, or topographical features. There is some evidence of ruins of communities or other structures, that were built in support of these early residents. Both Coronado and de Soto's expeditions passed through parts of this state. The people that originally settled much of the area were farming oriented, and even today ranching and farming are major state industries. This is true in much of the subject area, especially the smaller communities. There are various religious activities and festivities in some areas which have been practices for centuries by the Indians and still remain. In some places Indian arts, jewelry and handicraft is made and sold. Oklahoma has many lakes and rivers which have been developed for recreation values. The state advertises they have more miles of shore line (rivers and lakes) than any other of the continental 48 states.

III. ANALYSIS OF THE PROPOSED ACTION AND ALTERNATIVES

A. Environmental Impacts

1. Anticipated Impacts for Entire Planning Unit

a. Non-Living Components

Air

The impact of petroleum exploration and petroleum production on air quality will come principally from the emission of particular hydrocarbons into the atmosphere. There are aromatic odors from such emissions. Air pollution is caused by blowouts from production equipment and volatile fractions from oilspills. The burning of oil or other waste from draining pits contributes to air pollution. The occasional burning of oil and trash in remote areas may seem to be insignificant, however, the cummulative effect of numerous such small incidents could be a major problem. The open burning

of hydrocarbons in addition to those burned in the internal combustion engines from drilling operations and production operations add considerable pollutants to the atmosphere. Pollutants can be carried in the air long distances. The impact of pollution from the oil and gas activity is dependent upon climatic conditions and topography. Air quality in the immediate area of production would undergo some degradation. The most severe air pollution will occur at a time when there is an atmospheric inversion and a high intensity of operations.

Major problems may result during wind storms in any area that is extensively developed with roads, campsites, drillpads, etc. Dust is normally a problem each spring. Additional dust problems will result from vehicular traffic along dirt roads. This will usually be localized and of short duration except during windy conditions.

Lands

The effect geological or geophysical prospecting operations has on the environment is usally minimal and temporary. The greatest impact on the surface resource is done by vehicles and people traversing the terrain. The impact can be greater where shot hole seismic work is employed.

If operators will practice good housekeeping, the only impact left should be vehicle tracks. However, tire tracks can become ruts which often channelize running water during seasonal precipitation. This sometimes leads to serious gully erosion. Clearing vegetation and soil disturbances associated with the construction of access roads, drilling pads, and pipelines can increase the hazard of erosion. Drill pads are sometimes constructed on sloping ground. Consequently, a fill is needed to level the pad. The fill banks are steep and if left "as is" result in accelerated erosion from the loose soil. Vegetative removal increases overland flow loosening soil particles and transporting them downgrade. Destroying root systems permits increased mobility of soil particles below the surface. Improperly constructed, excessive numbers, poorly maintained and abandoned roads increase the potential for serious erosion. Poorly constructed road networks are found in some areas within the boundaries of the planning unit. Often roads are built for convenience rather than need. Accidents such as explosions, fires and oil spills, although occuring

infrequently, may reduce vegetative cover. The most likely damage would occur from oil spills. These would be very infrequent and would have to be relatively large to result in serious damage. Oil spillage can occur in several ways. It can be a major spill from ruptured pipelines or ruptured storage tanks, or it can be a minor spill from leaking pipelines or accident with transport trucks. Discarded oil from the oil field equipment is an additional impact. Occasionally, oil is drained onto the ground adjacent to roads and drill pads. Improper or poorly managed operations could result in additional unnecessary fire hazards. Good safety practices and proper stipulations would help prevent this.

Most of the soil when stripped of vegetative cover is subject to erosion through the activity of wind and water. However, the most serious gully erosion occurs on the steeper slopes and in those areas where light, more erodible soils occur. Waste products could have sterilizing effects on the soil and can cause surface pollution through spillage or by being left too close to the surface after pits are covered. This would depend on the toxic chemical content of the liquids in pits.

Oil and gas exploration and production could conflict with farming, ranching, watershed, wildlife or recreational uses of the land. Fences, cattleguards, and surface improvements are sometimes damaged through prospecting and construction of access roads, drill pads, pipelines and campsites. Geological and geophysical prospecting crews often have to go through fences. If gates are within reasonable distance from the intersecting point, the crews will use them; however, gates are not often so conveniently located. Consequently, fences are either cut or lowered to allow passage of equipment. Normally, the fences (and other damaged range improvements) are replaced in a good or better condition than they were originally. The exception, however, tends to cause considerable hardship and loss to other land users.

In Oklahoma it is the usual practice for any oil and gas operator to work in close cooperation with the land owners for access and/or construction of development facilities. Operators and field personnel usually lay out roads and pipelines on the shortest distances possible. In the past, oil and gas activity has resulted in some adverse environmental impacts but now most companies are required to use sound environmental principles in construction associated with oil and gas activities.

Water

Throughout most of the unit, water, for oil and gas operations, would be available from the several perennial rivers and streams or many lakes and reservoirs found through the state. It is unlikely that any such use of the water in this area would create a hardship on any rancher, farmer, or other resident there. Arrangement for use of water is made prior to the commencement of operations. Improperly located roads and pipelines will endanger surface water sources by increasing siltation loads in the drainage or interrupting the normal drainage flow. In some oil field production secondary recovery by water injection is sometimes employed to recover remaining oil. This process was discussed in the previous section. Hydraulic fracturing for gas production sometimes requires a large quantity of water. Oil and gas wells drilled in the area will likely encounter aquifers. These ground water sources can be contaminated by improper down-hole drilling techniques. The contaminates would be drilling fluid, brackish water, oil and/or gas being transported from one water bearing zone to another. This contamination is usually caused by careless operation or by accident. The ground water of the area is a previous commodity. USGS has expertise in ground water and should be consulted for precautionary or specific precautionary measures. It is a critical resource and very valuable to the area economy.

The improper construction of waste pits could result in contamination of surface waters. These surface waters (small streams, reservoirs, etc.) are important to the ranching industry, recreation, and to wildlife that inhabit the area. Surface water collects in natural lakes and ponds and man-made ponds from run-off

under sufficient precipitation. There is a possibility of contamination from oil spills; however, contamination of surface waters in the area may occur by accident or through gross negligence of the operator.

In the absence of an intensive research project, the effect of infiltration from liquid waste pits into the local aquifers is undetermined.

b. Living Components

Since the first oil or gas well that was put into production in Oklahoma, wildlife habitat and the associated wildlife species have decreased in numbers. With the continuous advance of human habitation and its accompanying clearing, farming and grazing practices, there have been major losses in natural habitat. Generally, this is due to a loss of the very essential components of their habitat. Habitat is critical for wildlife because when available it can supply their basic requirements of food, water, living space and protection from weather and enemies. These are the four essential needs of all living creatures and these needs must occur wherever animals live.

As time goes on and more oil and gas development occurs, some surface area is disturbed, vegetation is removed and the dangers of pollution to various water sources is increased. Oil and gas activity contributes to a smaller degree to one of the most serious issues affecting wildlife in Oklahoma. This issue involves the needless destruction of habitat: hedge rows that are bulldozed, the vegetation along ditches and road sides is removed and the cover available on woodlots and odd corners are reduced through clearing. However, some clearing of dense vegetation can benefit various wildlife species such as bobwhite quail, rabbits and other rodents and birds.

One of the most serious problems caused by oil and gas drilling operations is the seepage/leakage of drilling mud and chemicals onto the adjacent landscape and into surface and subsurface waters. This is usually the

result of one of the following: pipelines improperly built or constructed), mud, evaporation, or reserve pits, (breached or leaking), old wells which are improperly plugged and have corroded tanks, and the salting or spraying of oil on the roads or accidents. The result of some bad facilities or practices is the local decimation of the soil and vegetation or cover. The soil then becomes unproductive and sterile. Drilling mud in some cases is very acid. The acidity is usually derived from the chemicals contained in the effluent. These chemicals along with the salt water that is brought to the surface during drilling operations, will destroy the vegetation in a given area. Areas exist where salt water has destroyed the vegetation for as long as 20 years. Another problem that developed with old oil fields is that when these old wells were plugged (under old regulations) leakage from some of these plugged wells created pollution problems.

Where the pollutant is allowed to escape into surface or subsurface waters, the pollutant could be carried great distances which creates a more serious problem. The condition of water quality when salt water leaks into the various waters in small quantities over a period of time is such that the fish adapt to a slightly changed environment. However, if the pollutant is allowed to run into the waters in large quantities the fish as well as the aquatic food organisms cannot adapt and usually die. This is usually a result of ammonia (NH4), hydrogen sulfide (H_2S) and phenol pollutants which could come from reserve pits and other facilities. These type of pollutants can alter the alkalinity, hardness and PH of a water body (streams) up to several miles. As a result, fresh water, sand and gravel areas which are used for spawning and feeding are salted over with a gray mud, food organisms are suffocated, habit is limited and aquatic wildlife diminshes overtime.

There are some fish species that are very tolerant to some of these pollutants. These include the Red River pup fish (Cyprinodon sp.), top minnows (Fundulus sp.), and the mesquito fish (Gambusia sp.). In these areas where pollution is high, other clear water fish or non-tolerant fish are fast disappearing.

Another problem of concern in Oklahoma is a loss of wildlife on open pits which contain oil and toxic substances. The Oklahoma Game and Fish Commission Report that dead geese, quail and deer have been found in and near these pits. Few actual figures were available, however, the Commission feels that this problem is widespread and has had a impact on these wildlife species. In the one case, there were half a dozen dead deer within one hundred yards of one of these open pits.

The oil and gas development within Oklahoma is extensive. Usually roads are constructed as branches of or extensions from existing county, state, federal or private roads. The impact of road building on animals is minimal. The Oklahoma Fish and Game Commission considers new roads to be beneficial to game harvest in areas where access is limited.

The main impact on vegetation from oil and gas activity is the removal of vegetation by some mechanical means. Since most of the surface disturbance from oil and gas occurs on private land, the owner has the opportunity to invest this money in reclamation or to spend it elsewhere. Impacts on wildlife are felt where reclamation of disturbance sites is not done.

Much of the untreated disturbed area (that was once covered with perennials) grows back with an annual type cover. Other disturbed areas are put into cultivation. In any case some habitat is lost and some is improved depending upon the wildlife species affected.

c. Ecological Interrelationships

As in any action involving significant physical disturbance of a natural environment, oil and gas operations have and will produce chain effects on both micro and macro ecological interrelationships such as nutrient cycles, hydrologic cycles and energy flows. Specific

impacts will vary greatly with the intensity of the operation. For example, severe removal of vegetative cover and poor land use practice with resultant destruction of soil texture and increased erosion could increase run-off to the extent of producing local deserts within the more highly developed areas.

The existance of oil and gas activity over the past 50 years has created an impact on the area. It has not been measured as to the degree that these activities have affected the interrelationship of living and non-living components. There is no doubt, however, that the interrelationships have been affected, some positive and some negative. More observation and study must be made to determined these impacts. The most significant change in the ecological interrelationships would be on the activities of life styles of man.

In recent years it has become more apparent that man's knowledge of his actions on long-term ecological interrelationships is definitely lacking. Much additional study is needed and is under way in many cases. The true effect of various activities of oil and gas extraction on the nutrient cycle, hydrologic cycle and energy flow are not clearly identified. This effect may be of an immediate nature, such as complete removal of vegetation, topsoil or pollution of a spring and destruction of an endangered species in a specific area. On the other hand, the subtle change brought about by cumulative exploration activities may produce a more serious, long-term result if proper reclamation practices are not followed. While there is a great deal to be learned about some of the more subtle impacts of oil and gas operations on complex ecological interrelationships, more direct treatment can be given to specific components of these ecosystems and will be discussed in the other sections of this analysis.

d. Human Values

Seismograph and development crews may have sometimes accidently cut through valuable archeological sites. Unknown sites are sometimes uncovered. If discovery is made before serious damage has been done, it can some-

times render valuable scientific information. Extensive exploration activities over large areas of land usually produce a negative effect upon the visual environment. As a result of surface activity, long-lasting scars could result wherever a slow recovery rate of vegetation is found. The degree of visual impacts created during any development stage depend upon the extent of the discovery and the aerial extent of the oil producing structures that are found in the field. Oil and gas production has significant environmental effects where required standard production facilities and equipment such as well-head separators, storage tanks, compressors, pipelines, electrical transmission lines and access roads are located. In some of the areas debris accumulates as a result of oil and gas activity. Junk, litter and abandoned equipment might be scattered over the surface where there are improper oil and gas operational activities.

Unpleasant odors are prevalent at times in most oil and gas fields primarily due to emission of hydrocarbons either through unavoidable use or escape during development or due to carelessness. They are also prevalent in the production phase due to faulty or leaky valves and various production equipment. These problems are usually confined to a small area thus are not offensive to a large number of people.

Noise and vibrations from stationary engines used in drilling operations and production operations and in pipeline compressor stations disturb the natural environment. This kind of impact exists only for the time that the engines and other machinery are in operation. These are not considered serious problems because the area is large and has a moderate to sparse population density other than around the large cities. Oil and gas production facilities will leave roads drill pads and other facilities open to erosion. Some natural revegetation can be expected, without rehabilitation but it might be several years before perennial vegetation would re-establish itself without special rehabilitation measures. This is serious in the sense that many areas in Oklahoma presents a mood atmosphere associated with open spaces and moderate to sparse population. Past oil and gas activity has changed some of this atmosphere and it will continue to change as new oil and gas activities continue.

Unplanned construction of roads, rights-of-way and drill pads can do unnecessary damage to an area of high geological value. Structures such as precipitators and surface pipelines which are often times unable to be located in a less visible place, are painted colors (usually silver) which contrast with the natural beauty of the area. The subsequent activity of development due to leasing has had and will have a beneficial impact on geological knowledge. The activity of drilling will give a vast amount of knowledge of the sub-surface geology and hydrology.

The economy of any oil and gas prospecting or producing area always benefits from this activity. In some areas the oil and gas access roads would serve other people in the area beneficially.

e. Alternatives

The only alternative is not to issue leases for oil and gas. Although this alternative is not practicable, it would, if used, have no negative impact on the existing environment. There are, however, existing leases which will perpetuate surface activity for several years. The impacts of this activity, both positive and negative, are evident by observing existing effects that past oil and gas activities have had on the environment. Consequently, the alternative action of no leasing would have no immediate change on cumulative oil and gas impacts. It would cause a gradual reduction of surface activity from oil and gas due to expiration of existing leases.

2. Possible Mitigating or Enhancing Measures

Any possible mitigating measures must consider the need for continued production within the area because of the public need for the energy produced. The subsequent recommended mitigating measures (Part C) are designed to be implemented in one or more of the following actions:

1. When the notice of intent to conduct oil and gas exploration operations is received.

2. When leases are issued.

3. When application for a permit to drill is received by BLM from USGS or the lessee.

4. When notice of abandonment is received by USGS and BLM is subsequently contacted for recommendations.

5. When rights-of-way such as pipelines and powerlines are considered.

The BLM representative must examine potential conflicts with other activities. These conflicts must be identified and reconciled prior to the approval of the application. BLM and USGS representatives should examine all drill areas on Federal leases prior to the commencement of the operation. This provides for control of road construction through an on the ground examination of the proposed plan. Location of roads can be specified at this time to best limit any adverse impacts. In addition methods for rehabilitation of sites and surface protection should be discussed, i.e. (types of roads, and road drainage structures).

All future proposed surface use applications on Natural Resource Land will be examined closely and restricted or curtailed in any area considered to be critical, or an area that has some special use. If any land use is allowed in these critical or special use areas, it will be stringent stipulations for revegetation, rehabilitation and protection of the values that exist. This will insure further reduction of ground cover will occur due to oil and gas activities.

The General Rules and Regulations of the Oil and Gas Conservation Divisions (1972) which were written and adopted by the Corporation Commission of the State of Oklahoma should be required for each lessee or permittee. The most important mitigating measure is to fully evaluate each new lease application and drilling permit prior to its issuance. This should insure that proper protection and/or reclamation is provided.

All proposed vegetal clearing should be confined to as small an area as possible to minimize impacts. During geophysical prospecting vegetal clearing and surface disturbance should be limited. At other times any area

cleared should be closed and reseeded as soon as the proposed use is accomplished (pads can be seeded when well is in production). Strict measures should be taken upon final abandonment to insure that the best possible rehabilitation and protection measures have been taken.

Revegetation could be aided through stockpiling and retaining of top soil when drill pads are constructed. Stockpiling of top soil, however, should be throughly examined in each particular area. It is not necessary to stockpile topsoil if a subsurface material is determined to be adequate for revegetation. Fertilization is an alternative to replacement of topsoil on certain areas. Surface disturbance during all phases of oil and gas activity should be minimized thereby reducing the siltation and turbidity of any surface waters. Careful planning is needed to prevent the water pollution problems which are often related to drilling. These problems sometime develop because drill sites are located in or near drainages.

Location of drilling sites away from drainages and surface water can reduce the danger of water contamination from accidental spills and leaks.

Proper well casing procedures (as specified by USGS and Oklahoma State Laws) can reduce loss of ground water from the shallower aquifers. Reinjection of production water during secondary recovery efforts (water injection) can mitigate water loss by reducing the evaporative rate as well as reduce the salt pollution as described in the impacts section (the Corporation Commissions General Rules and Regulations).

Prior to the removal of well casings the District Manager should decide if the abandoned well can be used for fresh water sources. If there is a need for water, stipulations can be included in the lease to allow BLM to acquire the well.

Volatile liquid waste should be reinjected whenever possible or hauled away from the area. This waste should never be disposed of on the surface except when suitable disposal pits are available.

When these waste materials appear to have the potential for polluting surface and subsurface waters, these liquid waste materials should be contained in steal tanks and than hauled away to suitable disposal sites.

Subsurface fluids produced during drilling operations should be returned to that zone from which it was produced. These fluids can be disposed of by selecting deep zones not susceptible to movement and ones that do not outcrop on the surface.

To prevent leakage waste pits must initially be constructed deep enough so that waste products will be adequately covered when the pits are refilled. Selection of nonporous sites or a sealing method will be required to prevent leakage of corrosive fluid in ground water acquifers. These drilling fluids must be retained in place until a satisfactory method of disposal is found.

To protect wildlife species from the contents of waste pits these evaporative pits should be fenced or covered. Protection should insure that small mammals, birds, reptiles, etc. will be kept away from the contents of the pit.

There are several ways to mitigate impacts that may result from the fluids which flow from a well before or after drilling operations. One alternative is to require oil and gas companies to use tanks to contain fluids which may flow from the well during a drilling operation or after the well is operational.

Another method may require secondary or protective dikes around facilities (sludge or mud pits and drill sites). This will provide protection against accidents resulting from a washout or spill from such pits.

The impact from drill stem tests could also be reduced by requiring the operator to retain the fluids produced in steel tanks. These fluids would be removed from the site after completion of the test.

After drilling the operator should be required to rehabilitate the disturbed area. The operator can be required to haul off the drilling mud instead of breaching the pit and permitting the mud to run into nearby drainages and over vegetation. Physical removal of the drilling mud would prevent damage to streams and vegetation which could eventually harm fish and wildlife.

Back filling these pits maybe required, but adequate time as necessary to fully evaporate the liquid portions of the waste to allow proper conditions for cleanup. Pits could be filled, the area leveled and/or reshaped after abandonment and the top soil replaced if necessary. These sites would than be revegetated.

The potential for leaks and spills from pits, pipelines and flowlines can be reduced under a maintenance schedule system by requiring periodic testing of pipeline pressure systems under abnormal pressures and pit pressures. This is the responsibility of the operators which will be supervised by USGS in consultation with BLM (Attachment No. 6) and USGS by periodic inspections and compliance checks.

All roads permitted in conjunction with any phase of oil and gas should be closed or rehabilitated immediately after their intended use is fulfilled unless they are to become permanent roads. The District Manager with consultation of the lessee should decide which roads are to remain. The roads designated to be closed should then be revegetated.

Permanent access roads should be plated with gravel or comparable material to minimize dust pollution. Whenever possible the plating material should be taken from the existing disturbed areas. Oil and other substances should not be sprayed or spread on the roads that are used for access to an oil or gas operation.

The particular design, location and structures for each road should be determined on a case by case basis. Maintenance above the need to prevent erosion and rutting is undesirable because the moving of material back and forth needlessly will convert it to dust and contribute to air pollution. To aid in road maintenance and reduce erosion and unnecessary rutting, vehicles should be restricted to existing roads and trails during periods of extreme wet weather.

Erosion is a major environmental problem in oil and gas development. In order to control erosion, terrain and soils must be a foremost consideration for oil and gas well sites and facilities relating to oil and gas production. Impacts on soil erosion can be reduced by careful preplanning and by including specific mitigating stipulations in the lease or in the subsequent approved "application for permit to drill." These stipulations would provide for: reducing the area of impact to a minimum, rehabilitating disturbed areas, and constructing water control structures as applicable.

Soil erosion could be mitigated during prospecting. In this case clearing should be limited only to those areas where vegetation is too dense and/or the area is too large to go around. Earth moving in or near rivers or streams should be restricted. Crossing of streams or rivers should only be permitted where bridges exist and/or where a properly designed crossing with culverts can be constructed.

In frail areas containing federal minerals all further actions will be issued with stipulations that will require critical examination by a BLM representative when application to drill is submitted. The location and size of access roads, pipelines and pads and the possibility of restricting portions of the lease from surface disturbance will be determined at this time.

Various special recreation values must be mitigated. Roads, drilling sites, pipelines and other facilities should be located well away from present or proposed recreation facilities so that dust, noise and intrusions do not destroy the recreation potential. Roads, pipelines and drill pad location in some area should be preceded by a field examination. Professionals such as an archaeologist, paleontologist and others should be invited as needed. These people can more properly define the problem and mitigate any impacts that might occur from an oil and gas operation.

Reseeding with approved species should follow all soil disturbance at the earliest opportunity to reduce the visual impact of bare soil, blowing dust, impact on wildlife, reduce saltation and to prevent erosion. The narrowest roads and rights-of-way that will do the job should be required. This will reduce the amount of plants destroyed and the bare soil exposed to view.

Possible mitigating measures to maintain or enhance wildlife values involve the nutrient energy interlocking relationship factors of the life cycle of plants and animals. Measures to mitigate habitat lost in important wildlife use areas serve to maintain this cycle. Thus, the controlling of oil and gas activity by locating roads and drill sites and by reducing the intensity of activity will mitigate impacts. The impacts from oil and gas operations and associated activities upon various wildlife species and their important use areas may be found to be irrepairable. Therefore, a specific area could be withdrawn from all uses if it is definitely known that irrepairable damage would be done.

Mitigation of impacts to wildlife species and habitats can be done in such a way as to benefit many wildlife species. Clearing of vegetation such as in dense vegetation, (selective clearing) is a good method. Dense mature timberlands seldom offer much to most wildlife species. However, some mature mast bearing and den trees should be left for squirrels, raccoons and wood ducks. Openings in established stands of trees or brush encourages more use by wildlife by providing a greater variety of food and cover plants, better nesting and feeding places for their young. Clearing of brush and trees can also be beneficial if the debris is piled on the edge of the clearing or close to the clearing. These debris piles provide easy access to the new low growing vegetation within the clearing. When vegetation is removed or in areas where woody vegetation is lacking, the important "edge" can be created by planting shrub and tree species. The recommended planting season in Oklahoma is from December through March. Partial cover is as important in planting as it is with clearing techniques. Group of seedlings should be planted so that open spaces are broken up. Planting should include a mixed evergreen variety with hardwoods for cover just as in nature. Shrubs are an excellent overhead cover and should be used where brush is scarce. An important concept in revegetating a site is, the more varied the cover the more wildlife it will support.

When clearing sections of thick woody cover, be sure to leave as many nut trees as possible. Even if they occur in the center of the new opening. Fruit trees are also extremely attractive to most birds and animal species. Preserve these valuable food trees when clearing and if possible include them in all revegetation plans. The following are recommended for

Oklahoma EA

Note that there are general recommendations for the entire planning unit and recommendations for specific areas. Most areas are suitable for leasing, however, within some leases there may be areas which will need to be segregated from surface activity.

1. Stipulations and Guidelines

a. General (Minimal) Stipulations - Entire Planning Unit. The general surface disturbance stipulations for oil and gas leases, (Attachment #8) will be attached to all leases.

b. Additional Stipulations or Guidelines

The following stipulations or guidelines are designed for use as applicable on any action relating to oil and gas activities:

✓(1) Prior to any surface disturbance it will be necessary for the lessee to obtain archeological and paleontological clearance for the area involved.

(2) Roads crossing fences will have gates and/or cattle-guards constructed to BLM specifications.

(3) Any pipelines will be constructed within the area cleared for the access road when possible. The road should not exceed 20 feet in width. Clearing will not be done except where absolutely necessary for laying the line. Certain spots such as blind curves and hill tops may need to be wider for safety reasons.

(4) Construction of roads including culverts, turnouts, ditches or waterbars (thank-u-mams) will be done according to BLM specifications (Manual 9110-9115.68). (See Attachment #9). The maximum slope distance between waterbars (thank-u-mams) will be:

(a) For grades of 1% or less, the slope distance is 400 feet.

(b) For gardes of 1% - 5% the slope distance is is 300 feet.

(c) For grades of 5% - 15% the slope distance is 200 feet.

(d) For grades of 15% - 25% the slope distance is 100 feet.

(e) For grades greater than 25% the slope distance is 50 feet.

(5) Abandoned or unneeded roads will be closed off, reshaped and reseeded as determined by the authorized BLM official. Permanent roads should be plated with gravel or comparable material to minimize dust pollution. This plating material should be taken from existing disturbed areas.

Oil and other substances should not be sprayed or spread on the roads that are used for access to a oil or gas operation.

(6) All activities shall be confined to the access road and drill pad. Activities outside these areas must be approved in writing by the BLM.

(7) All access routes, roads and rights-of-way shall be located so as not to detract from aesthetic values (i.e., up mountain slopes, along well traveled highways, etc.).

(8) Roads will be located in pipeline or other utility or transportation corridors wherever possible.

(9) Existing improvements affected by oil and gas activity shall be maintained in a serviceable condition at all times. In the event any such improvements owned by the United States or its permittees or lesses are destroyed, immediate replacement or reimbursement for its full value will be made as determined by the responsible BLM representative.

(10) Upon completion of construction of the drill pad, a sign no less than 3 feet square shall be posted on the pad warning of the dangers of entering the site. This sign shall remain until all hazards are removed or remedied.

(11) No oil and gas surface activity shall be located in the bottom of any perennial stream course or lake without special approval of BLM. (In certain areas metal tanks may be necessary to hold all drilling mud which will be properly disposed of in an area designated by BLM).

(12) In certain areas where excavation will be extreme or where bedrock will be encountered, existing topsoil shall be replaced. The determination will be made at the site during the field investigation as to which site shall have topsoil stockpiled. Stockpiled topsoil (if any) shall be evenly distributed over the entire reseedable area of the drill pad before reseeding takes place.

(13) When gas is used in the drilling process, the line used to discharge and burn off the gas will be located so as not to damage vegetation in the area. If this is not possible, an earthern baffel will be constructed to keep the heat and residue within the operating area.

(14) The reserve pits shall be well constructed and under no circumstances will they be allowed to leak or be cut to drain. They shall not be located on natural drainages. All waste associated with the drilling operation will be buried in place or removed and deposited on an approved sanitary land filled. Waste or discharge of any kind will not be allowed to enter any drainage.

(15) The reserve pits will be covered immediately if they can be covered without disturbing any additional surface. Otherwise, the reserve pits will be fenced and the liquid portion will be allowed to evaporate before the pits are covered. Under no circumstances will the pits be cut and the residue spread over the site for drying purposes.

(16) Portable chemical toilets will be provided on all drill sites. Sewage will be disposed of in a manner that meets state and federal requirements. Solid waste will be stored in contained trash bins which will be buried periodically. The site will be clean at all times. Burning will not be allowed.

(17) Oklahoma Regulations for air quality must be complied with in disposal of hydrocarbons.

(18) All liquid hydrocarbons and chemicals shall be contained in evaporator pits. Any hydrocarbon or waste chemicals removed from the site shall be disposed of at a site approved by the authorized BLM official.

(19) Evaporation pits will be constructed and maintained so that runoff from heavy rains or snow will not cause breaching of the pit.

(20) Pipelines will be backfilled with dirt that is removed from the trench. A berm will be left on the top of the backfilled trench to allow for natural settling.

(21) During the clean-up operations, upon completion of drilling, all cut and fill banks will be sloped to conform with the adjacent landform and in no case steeper than 3:1.

(22) All drill sites, roads and pipelines will be rehabilitated. The operator will contact BLM in relation to the plan of rehabilitation of the site for the time of seeding and the seed mixture to be used. This will be done before release from bond by USGS. The authorized BLM official will be advised when the planting has been accomplished. If in the opinion of the authorized officer, the first seeding or planting is unsuccessful, he may require the lessee or grantee to make additional seedings or plantings.

(23) In areas where trees and/or brush is cleared, woody material is to be left in piles or scattered at random along the cleared area. It shall also be placed in drainages and worked down for erosion control.

(24) All oil surface pumping equipment shall be fenced to keep animals away and shall be properly posted to warn the public of the hazards.

(25) Any electric distribution lines constructed will conform with appropriate raptor protection stipulations.

(26) When any pole lines are abandoned, a designated number of poles may remain in place as determined by the authorized BLM official.

(27) Any evaporator pit found to contain toxic liquids will be fenced and/or covered and posted as directed.

(28) No oil and gas related surface activity will be allowed within approximately 100 yards of any Prairie Dog Towns.

(29) All structures and pipelines above ground shall be painted a color (non glossy paint) to blend with the surrounding area.

(30) Surface disturbing activities will come no closer than 100 feet to archeological mounds and pit houses and 300 feet to standing archeological structures.

(31) Crossing of streams or rivers should only be permitted where bridges exist. If a new crossing is needed culverts must be used.

(32) When clearing in dense vegetation: clearing should be selective not clear cut, some mature mast and fruit bearing and den trees should be left, some debris piles should be left along the cleared edge.

(33) When planting vegetation in disturbed sites a mixed evergreen variety with hardwoods and should be planted in groups so as to break up openings.

(34) The following plant species are recommended for Oklahoma soils and climate: autumn or Russian olive, wild black cherry, honeysuckle, red cider, mulberry, redhaw, wild crab apple, wild plum, sumac, black locust, mesquite, persimmon, osage orange, ponderosa pine, chittumwood, multiflower rose, buffalo berry and skunk brush. Herbaceous species such as Korean and cerezia lespidiza can be used.

(35) Maintenance of these access roads, roadsides and shoulder, especially the latter, should be kept to a minimum for the protection of wildlife. On road sides one swath of the mower may be cut for traffic safety. Cutting these shoulder areas should be avoided during the spring months to protect the wildlife species.

(36) Closed tanks will be used for reserve and mud pits. Earth excavation or fills for holding pits will not be allowed.

(37) Refuse must be cleaned and hauled from the site daily to prevent solid waste pollution on and off site.

(38) Top soil will be removed and stockpiled for redistribution over the disturbed area prior to reseeding of the site.

(39) Fertilizer and/or mulch will be applied to the disturbed area prior to reseeding the site.

4. Residual Impacts

a. General Impacts - Entire Planning Unit

Erosion is a major problem associated with oil and gas activities. The mitigating measures should be sufficient to control most of the erosion. In some cases the watershed will be improved and erosion reduced through application of these measures. The highest degree of impact will occur during the interim period of surface disturbance and successful application of mitigating measures. These impacts are relatively insignificant but are unavoidable.

Water resources although plentiful, are very valuable in the Oklahoma Planning Unit. Water quality is related to the impacts, mitigating measures and residual impacts on land as has previously been discussed. No significant residual impact exists on water. The water quality could stand in jeopardy because of the impact that might occur due to the failure of a mitigating measure or an accident such as an oil spill.

The residual impact on terrestrial plants is similar to that discussed under erosion. The removal of plants directly affects the impacts on other resource habitat removal land in the form of soil erosion, very seldom during the revege-

Oklahoma soils and climate: autumn or Russian olive, wild black cherry, honeysuckle, red cider, mulberry, redhaw, wild crab apple, wild plum, sumac, black locust, mesquite, persimmon, osage orange, ponderosa pine, chittumwood, multiflower rose, buffalo berry and skunk brush. Herbaceous species such as Korean and cerezia lespidiza can be used. The quality of those plant species should be considered when revegetation of a disturbed site is being done. Habitat for various wildlife species will be protected as well as improved if species such as those listed are used.

Specific sites or areas can also be protected with stipulations in the lease that regulate surface access or use. Usually an oil and gas well access road can be moved a short distance if there are good reasons for changing the drill location to a site which will have a much lesser impact. Maintenance of these roads, roadsides and shoulders, especially the latter, should be kept to a minimum for the protection of wildlife. On road sides one or two swaths of the mower may be cut for traffic safety. Cutting of these shoulder areas should be avoided during the spring months to protect the wildlife species.

A suitable location of the roads and trails used for access can be determined before work begins. Oil and gas companies can be required to use existing roads instead of constructing new roads, thus eliminating extra road and trail construction.

The BLM can include stipulations requiring rehabilitation of new trails as well as erosion protection. Roads associating with abandoned well sites should be closed off and rehabilitated. This will also restrict human activity in some areas, thus alleviating intrusions in rather undeveloped areas. In some areas careful locations of pads, roads and rights-of-way would mitigate the aesthetic impact adequately.

3. Recommendations For Mitigation or Enhancement

The District Manager may add surface protection and other environmental stipulations to the various leases, permits, and rights-of-way issued. The following stipulations have been developed and will be selected specifically as they apply to the individual action being processed.

tation process has the exact native species that were removed, been replaced. Often the replacement species vary for reasons such as superior watershed values, availability, economics, etc. The most significant residual impacts would be the impact of aesthetics due to the loss of native species and revegetation of introduced species leaving an aesthetic mark.

By identifying impacts and mitigating measures on various components of the interrelationship there remains no known void within this activity which does not have adequate mitigating measures. Therefore, there are few significant residual impacts in the interrelationships of the ecology.

Many human values stand to suffer some damage due to their irreplaceable nature. These items are or will be identified through inventory or survey before surface activity is allowed. Most residual impacts will be prevented if mitigating measures recommended in this analysis are followed.

b. Inventory and Mitigation of Post Oil and Gas Impacts

The existing activity has been previously discussed. Many of the existing negative impacts created by this previous activity could be lessened with proper rehabilitation procedures. This could be done on a cooperative basis after completion of a inventory by BLM and the various lessees. Any activity of this type will have to be programmed and funded at the district level because the present BLM staff and funds would not support this action.

B. Relationship Between Short-Term Use and Long-Term Productivity

The short-term period of the proposed action is expected to cover several years, as previously discussed. This use has impacts, some known and some unknown, some significant and some insignificant, which affect the interrelationship process. The majority of these known impacts are mitigated through measures previously listed. The cumulative affects of the residual impacts are not expected to significantly affect the environment. The total affect of the mitigating measures used during the short-term use may improve the productivity of the living components within the planning unit.

C. Irreversible and Irretrievable Commitment of Resources

All production of oil and gas can be assumed to be an irretrievable commitment of this resource because it is usually consumed relatively soon after it is extracted. Under these circumstances, the immediate value of that oil and gas is a resource which is lost.

At time due to error or negligence, a site of archeological or historical significance could be partially or completely destroyed due to surface activities. Due to the nature of these sites, their values are irretrievable once they are destroyed.

Throughout this environmental analysis of oil and gas activities, it has been stressed that surface disturbance, pollution (air, land, water) and associated facilities are of prime concern. These activities have varying effects on the environment depending on the intensity and magnitude. Though they are recognized as disturbing environmental factors, for the most part they are reversible, since eventually the sites will be restored and the facilities removed.

IV. Persons, Groups and Government Agencies Consulted

United States Geological Survey - Oklahoma City and Tulsa

Army Corps of Engineer - Tulsa

Bureau of Reclamation - Tulsa

Oklahoma State Oil and Gas Commission - Oklahoma City

Oklahoma Game and Fish - Oklahoma City
(Department of Wildlife Conservation)

Oklahoma Tourism and Recreation Department - Oklahoma City

Soil Conservation Service - Stillwater

Environment Protection Authority - Oklahoma City

School Land Leasing Department - Oklahoma City

Pollution Abatement - Oklahoma City

Bureau of Sport Fisheries and Wildlife - Oklahoma City

E. C. Jacobson (Maps) - Tulsa

V. INTENSITY OF PUBLIC INTEREST OR CONTROVERSY

The public is not overly concerned about the environmental impact of oil and gas activities in the Oklahoma Planning Unit. They are aware of the magnitude of the activity once they have accepted it as a way of life. They accept the fact that a major portion of the state economy and tax base depends on oil and gas activities.

how do we know?

There is no indication that continued issuance of oil and gas leases with provisions for protecting the environment will create any significant public concern or controversy.

VI. PARTICIPATING AGENCY STAFF

Lloyd Eisenhauer - Rio Grande-Las Vegas Area Manager
John Rhodes, Mining Engineer
George Hollis, Wildlife Biologist
J. W. Young, Assistant District Manager

VII. RECOMMENDATION ON ENVIRONMENTAL STATEMENT

If the recommendations in this analysis are implemented, we conclude that the environment will be adequately protected. Therefore, based on the assumption that the recommended mitigating measures are complied with and in accordance with the rationale listed in the Residual Impacts Section, it is recommended that an Environmental Impact Statement not be prepared.

VIII. SIGNATURES

Lloyd A. Eisenhauer — 8/29/74

[illegible] — 8/29/74

George B. Hollis — 8/29/74

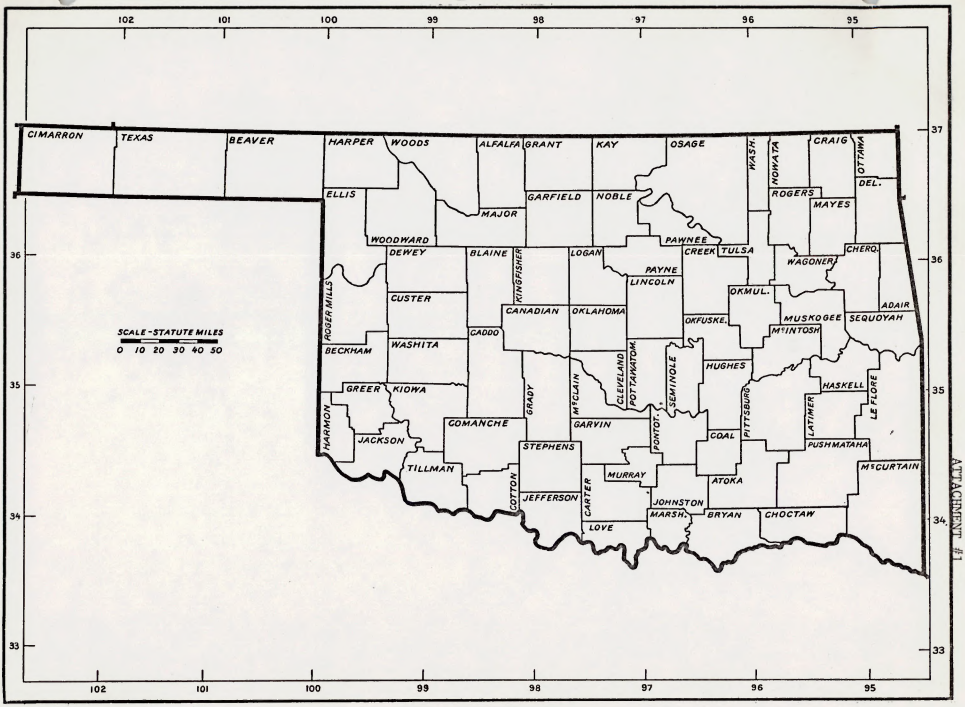
John B. Rhodes — 8/29/74

Concurred by/: R. Keith Miller — 8/29/74

R. Keith Miller, District Manager — Date

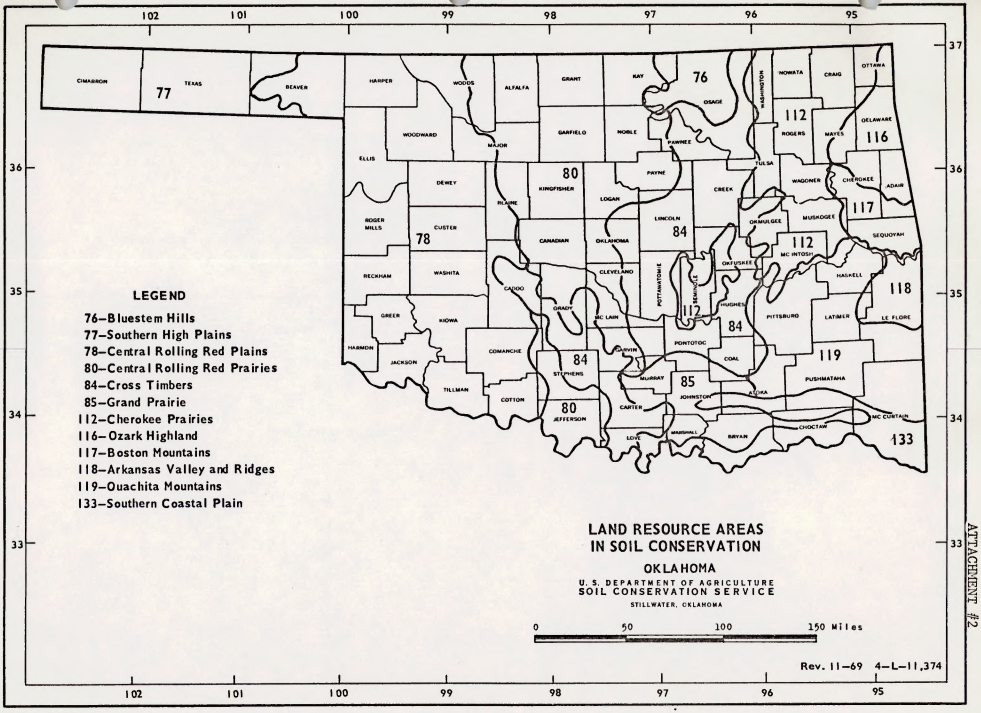
ATTACHMENTS

OKLAHOMA



ATTACHMENT #1

AD-400.34 11/58



ATTACHMENT #2

USDA-SCS-FORT WORTH, TEX. 1970

ATTACHMENT #3

Form 3107-1
(July 1967)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

NOTICE OF INTENT TO CONDUCT OIL AND GAS EXPLORATION OPERATIONS

Name	Address *(include zip code)*

hereby files this "Notice of Intent to Conduct Oil and Gas Exploration Operations" across and upon *(give description of lands by township(s) and range)*

The type of operation to be pursued is ☐ magnetometer ☐ seismograph ☐ other *(specify)*

roximate date of commencement of operations . Upon completion of , the Bureau of Land Management District Manager shall be furnished a "Notice of Completion of Oil and Gas ploration Operations."

The undersigned agrees that oil and gas exploration operations will be conducted pursuant to the following terms and conditions:

1. Exploration operations shall be conducted in compliance with all Federal, State and County laws, ordinances or regulations which are applicable to the area of operations including, but not limited to, those pertaining to fire, sanitation, conservation, water pollution, fish and game. All operations hereunder shall be conducted in a prudent manner.
2. Due care will be exercised in protecting lands in this notice. All necessary precautions shall be taken to avoid any damage other than normal wear and tear, to gates, bridges, roads, culverts, cattle guards, fences, dams, dykes, vegetative cover and improvements, and stock watering and other facilities.
3. Appropriate procedures shall be taken to protect any shafts, pits or tunnels, and shot holes shall be capped when not in use to protect the lives, safety, or property of other persons or of wildlife and livestock.
4. All vehicles shall be operated at a reasonable rate of speed, and due care must be taken to safeguard all livestock and wildlife in the vicinity of his operations. Bulldozers shall not be used without advance notification to the District Manager. Existing roads and trails shall be used wherever possible; if new roads and trails are made, care should be taken to follow natural contours of the lands where feasible and restoration and/or reseeding, as requested by District Manager shall be made.
5. Upon expiration, revocation or abandonment of operations conducted pursuant to this "Notice," all equipment shall be removed from the land and the land shall be restored as nearly as practicable to its original condition by such measures as the District Manager may specify. All geophysical holes must be safely plugged. Upon leaving the land, the District Manager shall be informed.
6. Upon request, the location and depth of water sands encountered shall be disclosed to the District Manager.
7. The party conducting such operations shall contact the District Manager prior to actual entry upon the land in order to be apprised of the practices which should be followed or avoided in the conduct of his operations in order to minimize damages to property of the United States.

(Signature)	(Signature of Geophysical Operator)
(Address including zip code)	(Address including zip code)

GPO 836-657

ATTACHMENT #4

United States Department of the Interior

GEOLOGICAL SURVEY

Conservation Division
Southern Rocky Mountain Area

NOTICE
(September 1, 1973)

To: All Lessees and Operators of Federal and Indian Oil and Gas Leases

In order that the Department may properly protect the environment during the development of all Federal and Indian leased mineral resources - Each Application for Permit to Drill under a Federal and Indian oil and gas lease must be accompanied by a Development Plan for Surface Use covering all proposed operations that might disturb the surface prior to commencing development work under the lease. One copy of the plan must be attached to each copy of the Application for Permit to Drill.

The Application for Permit to Drill and the Development Plan for Surface Use must be filed in sufficient time before you contemplate commencing any operations to allow adequate time for contacting the appropriate surface management agency and joint inspection of the proposed well location and access road where necessary.

A subsequent Development Plan for Surface Use must be submitted for approval when any changes in the proposed operation are necessary or if additional surface is to be used at a later date.

Work on roads and drilling locations must not be commenced prior to approval of the Application for Permit to Drill. A copy of the drilling permit and Development Plan for Surface Use must be posted at the drill site.

The following is furnished for your information and guidance in preparing the required Development Plan for Surface Use:

1. Existing roads including location of the exit from the main highway.

   This information should be submitted on a map (USGS topographic, county road, or oil field map with a scale sufficient to be legible) and include at least one locatable reference point and the main access road in the vicinity of the proposed location along with all existing roads within a minimum 3-mile radius of the proposed location. Trails and shortcuts need be shown only if they will be used for access. Additional required information under Nos. 2,3, and 4 below may be placed on this map if appropriately labeled.

2. Planned access roads.

This information should be submitted on a map and include all access roads that are to be constructed or improved upon or used in connection with the drilling and producing of the proposed well. Road construction should be kept to a minimum. Indicate the length and width of new road. Indicate whether roads will be compacted or surfaced. Operator should keep in mind that he may be required to restore the surface to its original condition.

3. Location of existing wells.

This information should be submitted on a map and include all wells (abandoned, temporarily abandoned, shut-in, injection, drilling, etc.) within a one-mile radius of the proposed location for a development well. For exploratory well drill sites, such information should be shown within a two-mile radius of the proposed location. An exploratory well is a well two miles or more from an existing Known Geologic Structure or if not established, two miles or more from an existing producible well.

4. Lateral roads to well locations.

This information should be submitted on a map and include all lateral roads to all well locations within one-mile radius of the proposed location. This information may be previously covered by the data given for Nos. 1 and 2.

5. Location of tank batteries and flow lines.

This information should be submitted on a plat or map showing the proposed location of the tank battery and flow lines associated with the proposed well in the event production is established. Future development of the lease should be considered in the location of the tank battery. Existing tank batteries and flow lines within a ½-mile radius of the proposed location should be shown.

6. Location and type of water supply (rivers, creeks, lakes, ponds, well, etc.).

This information may be shown on a plat or map or may be a written description. Source of all water to be used in the drilling operations of the proposed well should be noted. Location of necessary water lines should be indicated.

7. Methods for handling waste disposal.

A brief written description should be given of the methods for disposing of each type of waste material (cuttings, garbage, trash, etc.) from the drilling of the proposed well. If additional surface is to be used for disposal of any waste material from producing operations, a subsequent Development Plan for Surface Use must be submitted.

8. Location of camps.

Where applicable, this information may be shown on a map or plat, or be a written description of the location of the drill camp site. Any proposed permanent-type structures should be noted.

9. Location of airstrips.

Where applicable, any airstrip that is to be constructed or maintained for use during the drilling operations should be shown on a map.

10. Location of layout to include position of the rig, mud tanks, reserve pits, burn pits, pipe racks, etc.

This information should be shown on a plat with the approximate scale used and the compass direction shown. The general topography in the immediate area should be shown or described on the plat so the location of rig and associated facilities in relation to the surface features is apparent. Indicate whether drilling pad will be compacted or surfaced.

11. Plans for restoration of the surface.

State the proposed program for surface restoration upon completion of operation (stockpiling topsoil, leveling, reseeding, seed mixture, etc.). Such plans will be reviewed by the surface agency for adequacy.

12. Any other information that may be used in evaluating the impact on environment. Include general description of the topography, vegetation, and other aspects of the area.

Any available information that would be useful in evaluating the environmental aspects of the operation, including proximity to steep hillsides and gullies, cut and fill needed, etc., should be included. A photograph of the proposed drill site might expedite clearance.

<u>Furnish the name, phone number of your field representative responsible for compliance of the Development Plan for Surface Use.</u>

Form 9-331
(May 1963)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SUBMIT IN TRIPLICATE*
(Other instructions on reverse side)

ATTACHMENT #5
Form approved.
Budget Bureau No. 42-R142

SUNDRY NOTICES AND REPORTS ON WELLS

(Do not use this form for proposals to drill or to deepen or plug back to a different reservoir. Use "APPLICATION FOR PERMIT—" for such proposals.)

5. LEASE DESIGNATION AND SERIAL NO.

6. IF INDIAN, ALLOTTEE OR TRIBE NAME

7. UNIT AGREEMENT NAME

OIL WELL ☐ GAS WELL ☐ OTHER

2. NAME OF OPERATOR

8. FARM OR LEASE NAME

3. ADDRESS OF OPERATOR

9. WELL NO.

4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.* See also space 17 below.)
At surface

10. FIELD AND POOL, OR WILDCAT

11. SEC., T., R., M., OR BLK. AND SURVEY OR AREA

14. PERMIT NO.

15. ELEVATIONS (Show whether DF, RT, GR, etc.)

12. COUNTY OR PARISH

13. STATE

16. Check Appropriate Box To Indicate Nature of Notice, Report, or Other Data

NOTICE OF INTENTION TO:				SUBSEQUENT REPORT OF:			
TEST WATER SHUT-OFF	☐	PULL OR ALTER CASING	☐	WATER SHUT-OFF	☐	REPAIRING WELL	☐
FRACTURE TREAT	☐	MULTIPLE COMPLETE	☐	FRACTURE TREATMENT	☐	ALTERING CASING	☐
SHOOT OR ACIDIZE	☐	ABANDON*	☐	SHOOTING OR ACIDIZING	☐	ABANDONMENT*	☐
REPAIR WELL	☐	CHANGE PLANS	☐	(Other)			
(Other)							

(NOTE: Report results of multiple completion on Well Completion or Recompletion Report and Log form.)

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones pertinent to this work.)*

18. I hereby certify that the foregoing is true and correct

SIGNED _____ TITLE _____ DATE _____

(This space for Federal or State office use)

APPROVED BY _____ TITLE _____ DATE _____
CONDITIONS OF APPROVAL, IF ANY:

7/73

OKLAHOMA GUIDELINES
BETWEEN
BUREAU OF LAND MANAGEMENT
AND
GEOLOGICAL SURVEY
FOR
CARRYING OUT SECRETARIAL ORDER 2948

The term "area of operations" as used in the Secretarial Order delineates a geographic area in which the Geological Survey exercises the Secretary's delegated authority with respect to all surface and subsurface operations. For exploratory oil and gas drilling, the "area of operations" comprises the drilling pad. Maps delineating the area of operations for productive areas will be furnished BLM District Managers by the Survey. Such maps will be revised from time to time as necessary.

Within the "area of operations," Survey personnel are responsible for making final decisions, subject to BLM and GS agreement, regarding proposed operations, for contacting the operator, and for seeing that the required work is done. Survey personnel will work closely with BLM, will enforce stipulations necessary for the protection of the surface, and will not grant approval of any drilling operation without the prior consent of BLM. Operations outside of the "area of operations" are under the direct control of BLM personnel.

The GS will not issue a drilling permit which is inconsistent with BLM recommendations without further discussion with BLM. Any unresolvable disagreement with permit conditions will be settled under procedures established by Sec. 2(a) of Secretarial Order No. 2948.

BLM will:

1. Provide a representative for individual and/or multi-site field inspections.

2. Within five working days following the joint drill site inspection, or within ten working days after receipt of the Application for Permit to Drill by BLM, if no joint inspection is made, provide the GS with a report setting forth recommendations necessary to protect the surface resource.

3. Notify GS immediately of any necessity for joint field inspections of wells other than exploratory which may require GS representation.

4. As necessary, prepare an internal environmental analysis in order to determine impact and formulate recommendations to GS concerning Applications for Permit to Drill, on development wells.

APPLICATIONS FOR DRILLING PERMITS

USGS will:

1. Upon receipt of an application for a drilling permit, immediately send a copy of such application, with all attachments, to the proper BLM office.

2. Schedule a joint environmental analysis field inspection for exploratory wells and other wells in a known environmentally sensitive area to be made within three weeks from receipt of the Application for Permit to Drill. All effort by both agencies will be made to schedule the field inspection within 10 days from receipt of the Application for Permit to Drill.

3. Schedule the time for such inspections as soon as possible, considering work priorities; however, the BLM should be allowed at least seven working days prior to any commitment being made for an inspection date. Time may be reduced on high priority conditions.

4. Encourage the operators to submit field development plans or drilling schedules to permit lead time for evaluating environmental considerations, resource conflicts and land use planning alternatives and revised plans prior to official submission. Furnish BLM such plans or schedules and invite BLM participation.

5. So far as possible, schedule drill site inspections in order that several future drill sites, access roads, etc., can be inspected at one time.

PERMITS TO DRILL

USGS will:

1. Furnish immediate notification of all approved drilling permits to the appropriate BLM office. This will include, if not previously submitted to BLM, a copy of the agreed upon development plan, conditions and stipulations, and, if prepared by GS, the environmental analysis.

2. Require the operator to have a copy of the drilling permit, development plan, and any special conditions at the drilling site to help insure that on-the-ground contractors are completely aware of the drilling and surface protection requirements. The plan must be posted in a conspicuous location during all drilling and completion operations.

COMPLIANCE

USGS will:

1. Make periodic compliance checks to insure that permittee is living up to stipulations agreed upon between BLM and USGS.

2. Seek BLM assistance and expertise in circumstances involving surface management conflicts concerning stipulations and the operator's ability to meet them.

3. Notify BLM of non-compliance which may require rehabilitation plans.

4. Request the BLM to make compliance check if appropriate.

5. On spills such as pipeline ruptures, sludge pit breaks, etc., seek BLM expertise as to surface reclamation and rehabilitation.

BLM will:

1. At the request of GS or in the course of its own duties, note operator compliance with drilling permit stipulations and notify GS immediately of any non-compliance.

2. Contact the operator directly in cases involving an emergency found while performing field work, including spills, pipeline breaks, or other conditions immediately endangering health, safety, or significant resources.

GS will be notified of any actions of this nature immediately. At this time, agreement will be made with GS concerning resolution of the emergency and BLM's continued involvement.

ABANDONMENT

USGS will:

1. Notify BLM of cancellations or terminations of any permits issued, under which no activity has taken place.

2. Send BLM copy of all Notices of Intention to Abandon.

3. Approve and stipulate subsurface plugging by operator when appropriate.

4. If usable water has been discovered in the well to be abandoned, advise BLM for necessary action in accordance with existing procedures.

5. Not approve the subsequent Report of Abandonment until BLM confirms satisfactory completion of surface rehabilitation.

BLM will:

1. Take appropriate action under existing procedures when notified by USGS of usable water.

2. Work directly with the USGS concerning surface rehabilitation.

3. Notify GS of operator's satisfactory completion of surface rehabilitation.

4. Notify GS of any failure on the part of the operator to undertake surface rehabilitation measures required by BLM.

5. Request that USGS waive the requirement for an abandonment marker if desirable.

MAINTENANCE OF OIL AND GAS FIELD FACILITIES

USGS will:

1. Require operators to file, for approval, a suitable plan with GS prior to undertaking any maintenance, reconstruction or alteration of facilities, including roads, dams, reservoirs, etc., which will result in surface disturbance.

Operator must submit to GS enough information concerning the proposed activity to allow evaluation of possible surface disturbance.

2. Notify BLM of proposed surface disturbing activity and furnish available information.

3. Approve proposed action only after consultation with BLM.

4. Give operator approval to proceed subject to expressed conditions agreed upon by GS and BLM.

5. Make periodic inspections to assure proper operator maintenance of facilities.

BLM will:

1. Respond timely to GS's notification by providing recommended stipulations concerning the proposed action.

2. Cooperate with GS and operator in resolving conflicts concerning stipulations, if necessary.

3. Notify GS of any maintenance condition warranting correction. The BLM, on its own initiative, may make recommendations through USGS to the operator for the maintenance, restoration, and rehabilitation of existing conditions within a developed field.

GENERAL

USGS will:

1. As appropriate, coordinate and communicate with lessees and operators concerning area development plans and other information requirements prior to their submission of drilling applications.

BLM will:

1. If appropriate, communicate with lessees and operators prior to submission of drilling applications to expedite BLM's input concerning surface management.

BLM and USGS will:

1. Periodically hold joint meetings with lessees, operators, contractors and other involved parties to discuss problems, stipulations, working agreements, and other items of common concern.

2. May, as appropriate, enter into GS Area Office and BLM State Office level guidelines to further define responsibilities and mutual cooperation under S.O. 2948.

3. Meet together periodically at the BLM State Office and GS Area Office level to discuss past and future procedures under S. O. 2948.

ATTACHMENT #7

United States Department of the Interior

BUREAU OF LAND MGMT.

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

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STATE OFFICE
SANTA FE, NEW MEXICO

October 6, 1972

ORDER NO. 2948

Subject: Division of Responsibility Between the Bureau of Land Management and the Geological Survey for Administration of the Mineral Leasing Laws - Onshore

Sec. 1. Purpose. The purpose of this Order is to set forth the administrative and management procedures for Departmental onshore mineral leasing and operating activities. The spirit and intent of this Order flow from the Department's mineral management objectives of: orderly and timely resources development, protection of the environment, and receipt of fair market value for leased mineral resources.

Sec. 1(a) Orderly and Timely Resource Development includes the Department's responsibilities to:

(1) Foster, promote, and encourage the exploration for and the production of the mineral deposits from the leasable lands; promote competition;

(2) Encourage the active development of the mineral deposits in the leasable lands in a manner compatible with the use of the same lands for other purposes; assure that mineral developers receive the acreage necessary for economic plant investment, development, and production;

(3) Encourage the maximum ultimate recovery of the mineral deposit; prevent waste; promote the conservation of the mineral resources;

(4) Assure adequate minimum production and diligent development requirements for mineral deposits.

(b) Protection of the Environment includes the Department's responsibilities to:

(1) Assure that mineral exploration and production be conducted with the maximum protection of the environment;

(2) Assure the rehabilitation of disturbed lands;

(3) Assure that precautions are taken to protect public health and safety; and

(4) Assure full compliance with the spirit and objectives of the National Environmental Policy Act of 1969, other Federal environmental legislation, and supporting Executive Orders and regulations.

(c) Receipt of Fair Market Value for Leased Mineral Resources includes the Department's responsibilities to assure the public a fair market value return for the use of public lands and the disposition of its mineral resources.

Sec. 2. Agency Responsibilities. The BLM exercises at the Bureau level the Secretary's discretionary authority to determine whether or not leases, permits, and licenses are to be issued. The Bureau of Land Management is responsible for issuing mineral leases, permits, and licenses, and is the office of record in mineral leasing matters. The Geological Survey is responsible for all geologic, engineering, and economic value determinations for the Department's mineral management program. These determinations include: the mineral characteristics of lease and permit areas; parcelling; amounts of bonds; royalties; unit values; rentals; mineral resource evaluations; reserves; investment, diligent development, and minimum production requirements; and all other terms and conditions relating to mineral operations under leases and permits. Geological Survey exercises the Secretary's delegated authority regarding operations conducted within the area of operation by permittees, lessees, and licensees and determines the actions to be taken by them from the standpoint of the development, conservation, and management of mineral resources under the jurisdiction of the Department. GS will refer to BLM any instances of noncompliance with lease terms requiring cancellation action, and BLM will inititate the necessary action.

For the purpose of this Order, the area of operation is defined as that area of the present and planned mine, oil and gas field, or geothermal resource field exploratory, development, and production operations, as presented in an approved exploration or mining plan, drilling permit, oil, gas, or geothermal field development plan, or plan for the abandonment of wells or operations. The area of operation may cover a fraction of a lease or permit area, or it may cover several lease or permit areas. It encompasses the general area needed for storage piles, spoils piles, tailings ponds, on-project mill sites, flow lines, separators, surge tanks, storage tanks, on-project truck or rail-loading stations, drill pads, mud pits, workshops, compressors, generators, on-project power plants, and other such facilities used for on-project mine, oil and gas field, or geothermal resource field exploratory, development, and production operations.

(a) Environmental Protection. The Bureau of Land Management, in cooperation with the Geological Survey, formulates the general requirements to be incorporated in leases, permits, and licenses for the protection of the surface and non-mineral resources and for reclamation. The Geological Survey, before approving exploration and mining plans, drilling permits, oil, gas, or geothermal field development plans, or plans for the abandonment of wells or operations, consults with the Bureau of Land Management on the adequacy of the surface use, environmental protection, and reclamation aspects of the plans and will not grant approval if inconsistent with the BLM's recommendations without further discussions with BLM. If differences remain after these further discussions, the resolution is made by the Assistant Secretary--Mineral Resources and the Assistant Secretary--Public Land Management. If required, the Under Secretary resolves any remaining differences. The BLM is responsible for compliance examinations of environmental protection requirements outside the operating area and for reporting infractions to the GS for discussions with, or orders to, the permittee, lessee, or licensee. GS examines operations to ensure compliance with environmental protection and rehabilitation requirements inside the operating area. With respect to approval of access roads, pipelines, utility routes and other surface uses outside the operating area, the Bureau of Land Management has the primary responsibility but obtains the recommendations of the Geological Survey before taking final action. Orders to operators for any remedial action is the responsibility of the Geological Survey.

(b) Expertise. The Geological Survey is responsible for maintaining engineering, geologic, geophysical, economic, and other technical expertise needed by the Department to assure compliance with applicable laws, operating regulations, and the objectives of the Department's mineral management program. The Bureau of Land Management is responsible for maintaining expertise needed by the Department for action on applications filed with BLM under the mineral leasing laws to assure compliance with applicable laws, leasing regulations, and the objectives of the Department's mineral management program.

(c) Contacts with Applicants.

(1) Prior to the issuance of mineral leases, permits, and licenses, the Bureau of Land Management will represent the Secretary in dealing with applicants.

(2) After issuance and during the exploration, development, and production phases of leases, permits, and licenses, and until a lease, permit, or license has terminated (at which time management is the sole responsibility of BLM) the Geological Survey is the sole representative of the Secretary in all matters relating to the supervision of operations.

Sec. 3. Issuance of Mineral Leases, Permits, and Licenses.

(a) Applications. Prior to the issuance of mineral prospecting permits, leases, or licenses, the Bureau of Land Management refers all applications for such permits, leases, or licenses to the Geological Survey for a report as outlined in (b) below.

(1) The Geological Survey is responsible for determining, under the mineral leasing laws and regulations, if sufficient information is known about a mineral deposit to warrant offering the deposit for lease by competitive sale and to notify the Bureau of Land Management of its determination. If the Geological Survey finds that sufficient information is not available to warrant competitive leasing, it notifies the Bureau of Land Management of its conclusions so that the Bureau of Land Management may issue a prospecting permit or noncompetitive lease, as appropriate. The Geological Survey establishes prospecting requirements for prospecting permits. When lands are to be leased, the Geological Survey determines and reports, as appropriate, on: the mineral characteristics of lease and permit areas; parcelling; amounts of bonds; royalties; unit values; rentals; mineral resource evaluations; reserves; investments; diligent development and minimum production requirements; and all other terms and conditions pertaining to lease operations, including environmental and surface rehabilitation stipulations relating to mineral exploration and extraction. With respect to applications for licenses, the Geological Survey determines and reports as to whether the license may be issued.

(2) The Geological Survey is responsible for determining whether a prospecting permittee has demonstrated that the lands contain a mineral deposit having the characteristics required by law and regulations to qualify for a preference right lease and to notify the Bureau of Land Management.

(3) The Bureau of Land Management refers to the Geological Survey all other type applications received which, if approved, may affect operations on existing permits, leases, or licenses.

(4) The Bureau of Land Management notifies the Geological Survey of known oil, gas, and geothermal resource geophysical exploration activity, including the area involved, the type of survey employed, and the name of the operator.

(5) All applications for noncompetitive oil and gas, mineral, and geothermal resource leases filed with the Bureau of Land Management will, prior to issuance of a lease, be referred to the Geological Survey for a determination as to whether the lands are within a known geologic structure (KGS), a known geothermal resource area (KGRA), or a known leasing area (KLA).

(b) Mineral Resource Evaluation Report. GS is responsible for submitting a report of its findings, mineral resource evaluations, and resultant recommendations to the BLM, together with a summary explanation of how the resource evaluations were developed from geophysical, geologic, economic, and engineering data available at the time of the evaluation. The BLM reviews these findings and recommendations in light of multiple-use management requirements and will not issue leases or permits inconsistent with the findings and recommendations without further discussion with GS. If differences remain after further discussion, the resolution is made by the Assistant Secretary--Mineral Resources and the Assistant Secretary--Public Land Management. If required, the Under Secretary resolves any remaining differences.

(c) Competitive Lease Sales. The Bureau of Land Management advertises and conducts competitive lease sales. The Geological Survey's resource evaluations will be used and the Geological Survey will have representatives at the sale and renders a post-sale recommendation to BLM regarding acceptance or rejection of the bids, which must be confirmed in writing.

(d) Files and Records. BLM maintains the official application, permit, and lease case files and forwards to the Geological Survey a copy of each permit, lease, and license, together with copies of relevant correspondence thereafter conducted by the Bureau. The GS forwards to the BLM copies of mining and exploration plan applications, drilling permit applications, and relevant items submitted by the applicants directly to the GS, except confidential proprietary information cited under paragraph (e) below.

(e) Security of Information. The Geological Survey is responsible for receiving and protecting for the confidential use of the Federal Government all proprietary geological, geophysical, engineering, economic, statistical, or other information, mineral resource data, and well logs required to be submitted under Title 30 CFR, Parts 200, 211, 216, 221, 231, 270, and related regulations. The Survey Office receiving such information is designated the Office of Control for those data. Authorized officials of BLM or other surface-managing agencies having a need to see such information will normally make appropriate arrangements to visit the Office of Control for access to such data and for technical advice based on it pertinent to their management responsibilities.

Sec. 4. Mineral Reports. The Geological Survey is responsible for preparing and submitting to the Bureau of Land Management mineral classification and evaluation reports with respect to the leasable mineral value of lands within proposed exchanges, withdrawals, sales, land entries, or other disposals and all other land transactions. The Geological Survey, upon request, also prepares and furnishes mineral reports and other information to the Bureau of Land Management needed for its use in long-range multiple-use planning or inventory of the public lands.

Sec. 5. General Relationships. Such additional references, reports, interchange of information, and advice shall be made by or between the Bureau of Land Management and Geological Survey as may be necessary to perpetuate or improve current practice and provide effective administration of the mineral leasing laws.

The Bureau of Land Management and the Geological Survey must submit to each other for review and recommendations any proposed changes in standard lease terms, regulations, instructions, or other changes that would affect each agency's management responsibilities.

Sec. 6. Implementation of Order. It is intended that there will be no duplication by the BLM or GS of the functions assigned by this Order. BLM and GS will promptly bring their manuals and instructions into agreement with the terms and the spirit and intent of this Order.

Sec. 7. Revocation. The Secretary's instruction (procedures relating to the administration of the mineral leasing laws - General Land Office and Geological Survey) dated September 22, 1925 (51 L. D. 219) is revoked.

OCT - 6 1972

Secretary of the Interior

INT: 2029-72

ATTACHMENT #8

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

SURFACE DISTURBANCE STIPULATIONS
OIL AND GAS LEASE

Area Oil and Gas Supervisor *(Address)*

Management Agency *(name and address)*

1. Notwithstanding any provision of this lease to the contrary, any drilling, construction, or other operation on the leased lands that will disturb the surface thereof or otherwise affect the environment, hereinafter called "surface disturbing operation," conducted by lessee shall be subject, as set forth in this stipulation, to prior approval of such operation by the Area Oil and Gas Supervisor in consultation with appropriate surface management agency and to such reasonable conditions, not inconsistent with the purposes for which this lease is issued, as the Supervisor may require to protect the surface of the leased lands and the environment.

2. Prior to entry upon the land or the disturbance of surface thereof for drilling or other purposes, e shall submit for approval two (2) copies of a map and explanation of the nature of the anticipated activity and surface disturbance to the Area Oil and Gas Supervisor and will also furnish the appropriate surface management agency named above, with a copy of such map and explanation.

An environmental analysis will be made by the Geological Survey in consultation with the appropriate surface management agency for the purpose of assuring proper protection of the surface, the natural resources, the environment, existing improvements, and for assuring timely reclamation of disturbed lands.

3. Upon completion of said environmental analysis, the Area Oil and Gas Supervisor shall notify lessee of the conditions, if any, to which the proposed surface disturbing operations will be subject.

Said conditions may relate to any of the following:

(a) Location of drilling or other exploratory or developmental operations or the manner in which they are to be conducted;

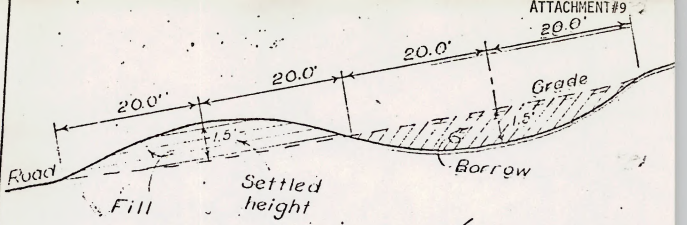
(b) Types of vehicles that may be used and areas in which they may be used; and

(c) Manner or location in which improvements such as roads, buildings, pipelines, or other improvements are to be constructed.

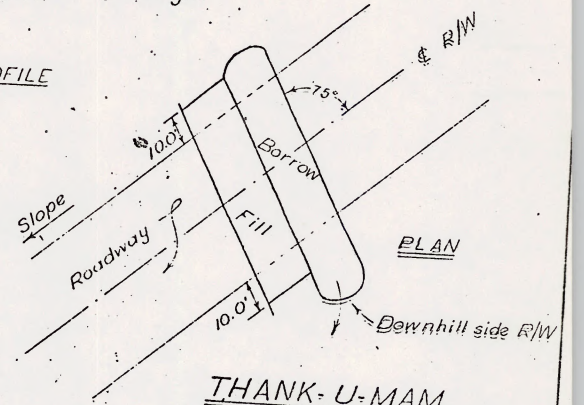
Form 3109-5 (May 1973)

U.S. Government Printing Office: 1973—784-259/2263 Reg.

ATTACHMENT #9



PROFILE



PLAN

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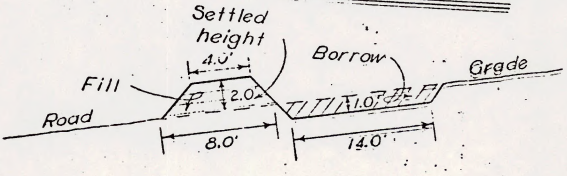


DIKE

No Scale

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
NEW MEXICO

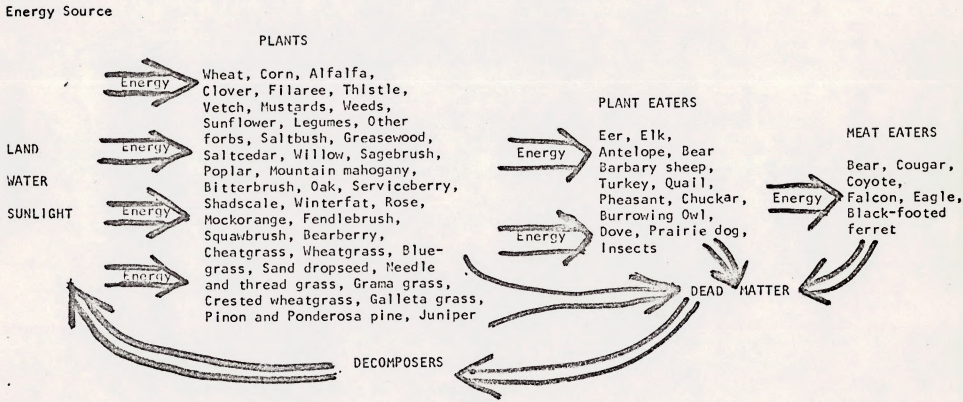
ALBUQUERQUE DISTRICT

NM 7 Sketch

M1 9-15-69

TERRESTRIAL - ECOLOGICAL INTERRELATIONSHIPS

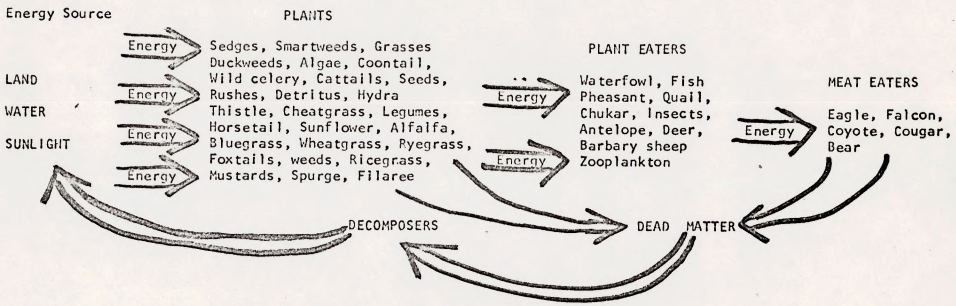
Chart 1



ATTACHMENT #10

AQIATIC - ECOLOGICAL INTERRELATIONSHIPS

Chart 2



ATTACHMENT #11

Remarks: Alternatives: "no action=only impact would be severe impact on local economy & slight impact on supply of nation's natural resources. 2. Lease with restricted areas this would have the same impacts as described below on areas when drilling would be allowed. Where drilling would be restricted there would be no impact.

STAGES OF IMPLEMENTATION	EXPLORATION (includes pre-lease)					
DISCRETE OPERATIONS	Magnometer Crews	Seismograph	Vibraseis	Gravimeter	Geologic Survey Parties	REMARKS
I. NON LIVING COMPONENTS						
A. AIR						
Particulate Matter	0	-L	-L	0	0	
Carbon Monoxide	-L	-L	-L	-L	-L	Result of overland & aerial travel
Hydro Carbons	-L	-L	-L	-L	0	equipment very slight.
B. LAND						
Soil Erosion	0	-L	-L	0	0	
Soil Pollutants	0	-L	0	0	0	
Land Use Capability	0	0	0	0	0	
C. WATER						
Sediment Load	0	-L	-L	0	0	May occur due to surface disturbance
Turbidity	0	-L	-L	0	0	and subsequent erosion.
II. LIVING COMPONENTS						
A. PLANTS (AQUATIC)						
Shrubs and Trees	0	-M	-L	0	0	Removal of vegetation in or near an
Grasses and Forbs	0	-H	-L	0	0	aquatic environment has a larger impac cover and food due to larger numbers
B. PLANTS (TERRESTRIAL)						of wildlife present in aquatic areas. Impacts are highly local.
Grasses	0	-L	-L	0	0	
Forbs	0	-L	-L	0	0	
Shrubs	0	-L	-L	0	0	

STAGES OF IMPLEMENTATION	EXPLORATION (includes pre-lease)					
DISCRETE OPERATIONS	Magnometer	Seismograph	Vibrasis	Gravimeter	Geologic Survey Parties	REMARKS
C. ANIMALS (AQUATIC)						
Mammals	0	-M	-L	0	-L	A greater number of
Birds	0	-M	-L	0	-L	wildlife species inha-
Reptiles & Invertebrates	0	-H	-L	0	-L	bit these areas; there-
Fish						fore the impacts are
D. ANIMALS (TERRESTRIAL)						locally significant.
Mammals	0	M	-L	0	-L	Disturbance to habitat
Birds	0	M	-L	0	-L	is highly local. Slight
Reptiles & Invertebrates	0	M	-L	0	-L	disturbance of activi-
						ties of animals due to
III. ECOLOGICAL INTERRELATIONSHIPS						the presence of man & machine breaking up the routine.
A. ECOLOGICAL PROCESSES	0	-L	-L	0	-L	Only if the presence of
Hazards to human and						man is considered to be
animal health and safety	-L	-L	-L	-L	-L	foreign to ecological
						interrelationships.
IV. HUMAN VALUES						No particular hazard except due to the necessity to use equipment surface & aerial. A ~~hazard is there.~~
A. LANDSCAPE CHARACTER						
Visual	0	-L	-L	-L	-L	
Sound	0	-L	-L	0	0	Very slight due to ligh
Odor	0	0	0	0	0	activities - trails,
Mood Atmosphere						of each item.
B. SOCIOCULTURAL INTERESTS						
Economic		+L				
Cultural		L				Controversial
Social		L				Controversial
Archeological	0	-L	-L	-L	-L	In event some sites
Geological	+H	+H	+H	+H	+H	are damaged.
Historical	0	0	0	0	0	

Remarks:

STAGES OF IMPLEMENTATION / DISCRETE OPERATIONS	Above Ground Pipeline	Reserve Pit, Drilling Tank Batteries, Prod. Water, Disp. Pit, Assoc. Activ.	Waste Disposal Roads & drill pads (construction)			DEVELOPMENT REMARKS
I. NON LIVING COMPONENTS						
A. AIR						
Temperatures	0	0	X	X	X	May raise temp. due to gas blooie line or reflection from cleared road and pad.
Particulate Matter	0	0	-L*	-L*	-M*	
Carbon Monoxide	0	-L	-L*	-L*	-L*	*Due to burning &/or dust
Hydrocarbons	-L	-M*	-M*	0	0	*Impact depends on precautions taken to avoid accidental spills or sloppy operating practices.
B. LAND						
Soil Erosion	-L	0	-L	0	-M	
Soil Pollutants	0	-M	-M	-M	0	
Land Use Capability	X	-L	0	0	-M	
C. WATER						Water quality (pH, chemical and toxic substances) is lowered locally
PH	0	-L	-H	X	X	All items depend on proximity to water and to practices of contaminant & control - Checklist is made under present practices of cutting res. pits - Allowing frac. water to flow freely, etc.
Nutrients	0	X	X	0	X	
Sediment Load	X	-L	-L	0	-M	
Chemicals & Toxic Substance	0	-M	-H	X	0	
II. LIVING COMPONENTS						
A. PLANTS (AQUATIC)						Impact due to clearing discharging effluent on and beneath the soil surface.
Shrubs and Trees	-L	-H	-H	-M	-H	
Grass and Forbs	-L	-H	-H	-M	-H	
B. PLANTS (TERRESTRIAL)						
Grass	-L	-H	-M	-M	-H	Impact due to clearing
Forbs	-L	-H	-M	-M	-H	
Shrubs	-L	-H	-M	-M	-H	
Conifers	-L	-H	-M	-M	-H	
Broadleaf	-L	-H	-M	-M	-H	

STAGES OF IMPLEMENTATION						
DISCRETE OPERATIONS	Above Ground Pipeline	Reserve Pit Drilling Tank Batteries	Prod. water, Disp. pit Assoc. activ.	Water Disposal	Roads & drill pads (construction)	REMARKS
C. ANIMALS (AQUATIC)						
Mammals	-L	-M	-M	-L	-M	Impacts are locally
Birds	0	-M	-M	-L	-M	significant except wher
Fish	*-H	*-M	*-H	*-H	*-H	pipeline or pit breaks
Reptiles & Amphibians and Invertebrates	-L	-M	*-H	*-H	-M	occur. *Impacts are much greater to fish
D. ANIMALS (TERRESTRIAL)						and other aquatic life
Mammals	-L	M	-M	-L	-M	forms when drilling
Birds	0	M	-M	-L	-L	effluents are not con-
Reptiles & Invertebrates	-L	M	-M	-L	-M	tained and sedimentatio
						increases.
III. ECOLOGICAL INTERRELATIONSHIPS						Moderate impacts to the
A. ECOLOGICAL PROCESSES Ecological Stress	-L	-M	H	-L	-M	animal life are local- ized not widespread.
Productivity	X	-L	H	0	-M	
Hazards to Human and Animal						
Health and Safety	-L	-H	-M	-L	-M	
IV. HUMAN VALUES						
A. LANDSCAPE CHARACTER Surface	-L	-H	-H	-M	-H	Due to visible smoke,
Visual (Atmosphere)	0	-M	-L	-L	-M	dust & structures.
Sound	0	-M	-L	0	-M	
B. SOCIOCULTURAL INTERESTS						
Archeological	-L	-H	-H	-M	-H	Possible high damage
Geological	0	-L	0	0	0	in areas not properly
						identified.

ENVIRONMENTAL ANALYSIS WORKSHEET

Remarks: _____

STAGES OF IMPLEMENTATION	PRODUCTION						
DISCRETE OPERATIONS	Above Ground Pipeline	Roads (Maintenance)	Drill Pads	R/W	Structures	Blowoff Pit	REMARKS
I. NON LIVING COMPONENTS							
A. AIR							
Particulate matter		-M	-L	0	0	0	Due to vehicle travel & dust.
Carbon monoxide		-M	0	X	X	X	
Hydro carbons		0	0	-M	-M	-M	In event of malfunction or poor maintenance that allow leaks or breaks & subsequent discharge of hydrocarbons.
B. LAND							
Soil erosion	0	-M	-M	-M	0	X	
Soil pollutants	-L	0	-L	-H	-H	-M	*In case of leak or break.
Land Use capability	-L	-M	*0	*0	0	-M	*If properly rehabilitated.
C. WATER							
PH		0	0	0	0	X	
Sediment Load		-L	-L	-L	0	X	Will depend on amount & success of rehabilitation and construction of secondary dikes around pits or use of steel tanks to contain drilling fluids.
Dissolved solids		0	0	0	-X	-X	
II. LIVING COMPONENTS							
A. PLANTS (AQUATIC)							Impacts are high initially. Once structures have been done and vegetation reestablished the impacts are not as great. Some iritical habitat may be lost.
Shrubs and Trees		0	-H	-M	0	-H	
Grasses and Forbs		0	-H	+M	0	-H	
B. PLANTS (TERRESTRIAL)							Impacts are negative initially. If stipulations for revegetation are followed a beneficial impact is the result. Area has been cleared of competition allowing recovery thus improved conditions
Grasses		-H	+M	+H	0	-M	
Forbs		-H	+M	+M	0	-M	
Shrubs		-H	+M	+M	0	-M	
Conifers		-H	+L	+L	0	-M	
Broadleaf trees		-H	+L	+L	0	-M	

STAGES OF IMPLEMENTATION		PRODUCTION					
DISCRETE OPERATIONS	Underground Pipeline	Roads (maintenance)	Drill Pads	R/W	Structures	Runoff Pit	REMARKS
C. ANIMALS (AQUATIC)							* If breaks occur
Mammals	*-L	-L	+L	+M	+M	-M	a high negative
Birds	*-L	0	+L	+M	+M	-M	impact could occur
Fish	*-L	-M	-L	0	+M	-M	Other impacts are
Reptiles Amphibians Invertebrates	*-L	-L	+L	+M	+M	-M	negative initially
D. ANIMALS (TERRESTRIAL)							due to removal of vegetation. Prop-
Mammals		-L	+M	+M	-L	-L	er seeding espe-
Birds		0	+M	-M*	-L	-M	cially along R/W
Reptiles & Invertebrates		-M	+M	+M	0	-M	can create valu-
							able habitat.
III. ECOLOGICAL INTERRELATIONSHIPS							*only if R/W is powerline it may
A. ECOLOGICAL PROCESSES		-H	-L	-L	0	-M	affect larger species of dense
		-H	-M	-M	-L	-L	vegetation. Clear
Hazards to Human and Animal							ed areas properly
Health and Safety	-L	-M	-L	-L	-M	X**	revegetated are
IV. HUMAN VALUES							beneficial to wild life. Initial im-
A. LANDSCAPE CHARACTER Surface		-H	-M	-M	-H	-L	pact is high.
Visual (atmosphere)	-M	-L	0	0	-L	-L	**Clearing sets
Sound		-L	0	0	-M	0	back ecological
Odor		0	0	0	-L	-M	succession but
Nood Atmosphere	-M						opens up dense
B. SOCIOCULTURAL INTERESTS							stands of vegeta- tion.
Archeological		-L	0	-H	0	-L	
Geological		0	0	0	0	0	

Remarks: All components are considered with the assumption that the recommended mitigating measures have been compiled with

STAGES OF IMPLEMENTATION						
DISCRETE OPERATIONS	Surface Disturbance Drill pads, roads, pipelines, etc.		Surface Cleanup (Litter)	ABANDONMENT		REMARKS
I. NON LIVING COMPONENTS						
A. AIR	+L		X			
B. LAND	+M		+M			Compared to Production Phase
C. WATER	+M		+M			
II. LIVING COMPONENTS						
A. PLANTS (AQUATIC)	+H		+M			Removal of equipment and facilities and reseeding of pad, road etc. will enhance the habitat. With proper selection of appropriate enhancement can be high.
B. PLANTS (TERRESTRIAL)	+H		+L			

	STAGES OF IMPLEMENTATION					ABANDONMENT	
	DISCRETE OPERATIONS	Surface disturbance drill pads, roads, pipelines, etc.		Surface cleanup (litter)			REMARKS
C.	ANIMALS (AQUATIC)						If habitat is enhanced as in part IIA than wildlife will benefits provided that initially the production site was properly located surfac disturbance minimized structures built and th site revegetated after termination of activity
		+H		+H			
D.	ANIMALS (TERRESTRIAL)	+M		+H			
III.	ECOLOGICAL INTERRELATIONSHIPS						
A.	ECOLOGICAL PROCESSES	+L		+L			
	Hazards to Human and Animal	X		+M			
	Health and Safety						
IV.	HUMAN VALUES						
A.	LANDSCAPE CHARACTER						
	Visual	+M		+M			
	Sound	0		0			
	Odor	0		+L			
	Mood Atmosphere	+M		+M			
B.	SOCIOCULTURAL INTERESTS						
	Educational/Scientific	0		0			
	Historical	0		0			
	Cultural	0		0			

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